N-63-4-2

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FINAL REPORT

11 March 1963

Recovery and Decontamination Measures after Biological and Chemical Attack

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

Contract OCD-OS-62-183

Prepared for
Office of Civil Defense
Department of Defense

by

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RECOVERY AND DECONTAMINATION MEASURES AFTER BIOLOGICAL AND CHEMICAL ATTACK

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DEPARTMENT OF DEFENSE
OFFICE OF CIVIL DEFENSE
WASHINGTON 25, D.C.

INTRODUCTION

This constitutes the final report on the project for preparation of a "state-of-the-art" handbook on BW/CW recovery and decontamination measures, for use by civil defense officials. It is appropriate to review the underlying concepts; the techniques used in collecting, evaluating and presenting the information; and the problem areas identified.

The handbook is designed to be of the maximum practical utility to local civil defense officials.

The audience comprises civil defense officials and municipal technical specialists who will be directly concerned in decontamination planning, technical preparation, training, and task operations. Chapter 1 of Part I serves as an orientation for them also, while Chapter 2 gives concrete and practical guidance on planning and organizing for decontamination.

Part II--Decontamination Operations--is a technical reference source giving specific information on decontamination materials, procedures, and applications. As such it serves as a basis for planning, preparation and training. Equally important, it is designed for quick reference in directing actual decontamination operations.

The principal categories of documentary sources were:

a. Military operational and doctrinal manuals, e.g., Field Manuals, Technical Manuals.

b. Research and survey reports of military agencies and Department of Defense contractors.

c. Pertinent similar documents from civilian Federal agencies, particularly the Public Health Service, Food and Drug Administration, Agricultural Research Service, and Business and Defense Services Administration.

d. Publications of professional societies and trade associations, including the American Medical Association, American Chemical Society, National Pest Control Association, and American Institute of Laundering.

e. Brochures and other material from commercial suppliers of chemicals, spray equipment, and protective equipment.

f. Representative local civil defense plans, including health services.

Since decontamination is the over-all objective of the handbook, this aspect of defense is thoroughly reviewed in Chapter I. It serves as an orientation for municipal officials with general responsibilities and as an introduction to the specifics of the problem for civil defense officials with direct responsibility. The discussion is confined to materials, equipment and methods which can reasonably be expected to be available in the community.

Chapter 2, on organization and planning, is based on an analysis of typical municipal organizations and local civil defense plans. This provided a framework into which to fit the operating requirements developed from the military programs. Thus the recommendations are made consistent with civilian institutions. The chapter identifies potential resources, both governmental and non-governmental, and defines the key elements to be considered in planning.

Part II is designed as an operating handbook, complete in itself. As such it repeats some material given in Chapter 1, but gives specific details on materials, quantities, methods and precautions.

To plan for countermeasures against any weapons one must understand the problem--the nature, the potentials, and the limitations. This research project and the resultant final report were intended to bring together current information most applicable to civil defense. It was particularly intended for those who are responsible for planning preparatory, reclamation and countermeasures effort to minimize the damage from a BW/CW attack.

William J. Lacy
Project Coordinator
Postattack Research

CHAPTER I

PRINCIPLES OF DECONTAMINATION

The preceding chapters, by describing the BW/CW hazard and the defensive actions that can protect a civil population, provide a realistic perspective for the role played by physical decontamination. This chapter points out the important assists given by natural phenomena to organized decontamination operations, and reviews the decontaminating principles the community can apply.

This chapter and the next will help the community official to recognize community resources having special value for BW/CW defense operations, so he may take steps needed to incorporate them in the prearrangements existing for other types of emergency supplies.

The civil defense specialist will obtain an increasingly specific bill of particulars, starting with this chapter, regarding decontaminating tools -- equipment, facilities, supplies, and techniques -- available from resources existing in the typical community and home, and in civil defense stocks.

CHAPTER I

PRINCIPLES OF DECONTAMINATION

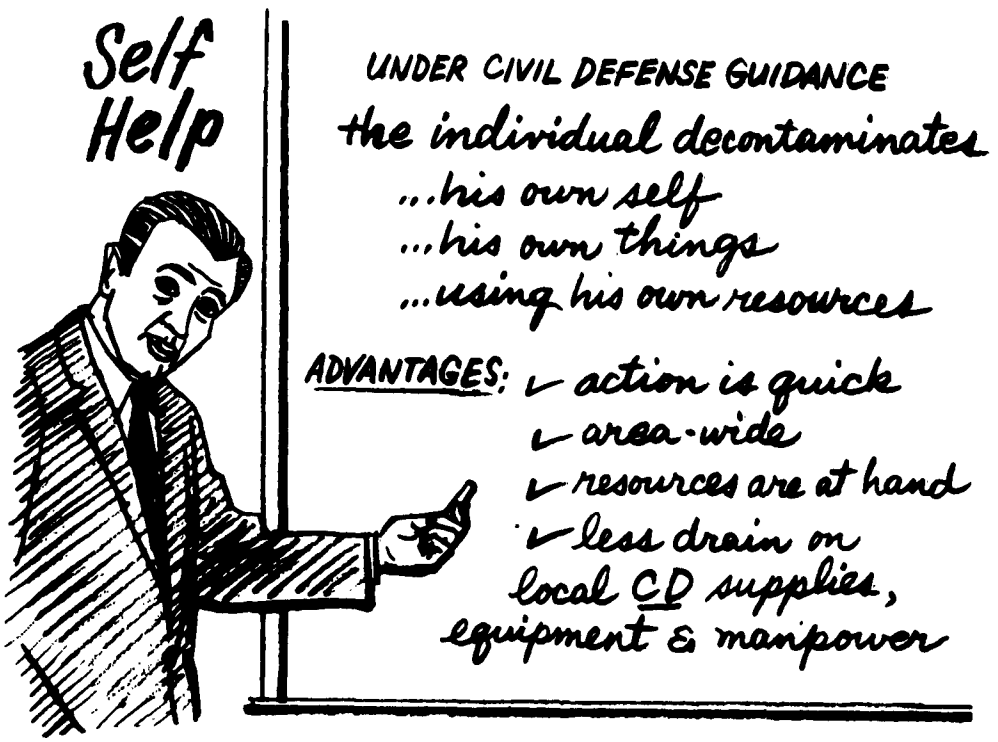
The Decision to Decontaminate

Decontamination has the purpose of eliminating a biological or chemical hazard remaining after an attack. It is accomplished by destroying, removing, or covering the contamination, or changing it to a harmless substance. Individuals who had not been harmed by the direct attack might later be affected by contact with the residual agents, by breathing a secondary aerosol, or by eating or drinking contaminated food or water. Objects requiring decontamination may be interior or outdoor areas; food, water, and clothing; tools and equipment -- even individuals.

Effective decontamination actions rest on three primary considerations:

- First, something must be contaminated and we must know it. This means that we must know that an attack has occurred, have some knowledge of the nature of the agent, and an indication of the areas and objects which have been contaminated.
- Second, there must be a necessity for decontamination. The need for the contaminated objects, or the use of the contaminated area, must be great enough to establish an effective priority claim on the personnel and supplies in demand for rescue, rehabilitation, and other recovery activities.
- Finally, there must be a suitable and practical means of decontamination. The proper supplies must be on hand, the personnel involved must know how to use them, and the task must be possible of accomplishment in the required time.

Nearly all decontamination operations can be placed in one of two major classes. The first comprises individual or self-help methods. This includes measures taken by an individual to decontaminate himself, his food, personal water supplies, and items of personal use, using resources immediately available to him. When self-help methods can be employed they have many advantages -- immediate application, conservation of scarce materials, and minimizing the load placed on the civil defense organization.



The other category comprises operations undertaken by, or under the direction of, the local civil defense organization. These would include decontamination of food stocks other than those in the hands of individuals; protection of public water supplies; operation of personnel

decontamination stations; and decontamination of areas or building interiors where there is a critical need to utilize them.

As the civil defense specialist inventories decontamination methods and materials most suitable for his local conditions he will recognize that some are applicable to individual or home use, and others are more appropriate to the large-scale organized operations by civil defense units.

In considering organized decontamination operations, the important factor of time enters into these three key appraisals:

- Time the contamination would persist if left alone.
- Time the contamination can be allowed to remain.
- Time that would be required to decontaminate.

Comparison of these time factors will help establish the net benefit to be achieved by a decontamination operation.

The Four Approaches

Many decontaminating procedures are effective against both chemical and biological agents and several are also effective against radioactive fallout. Decontamination methods involve one of four approaches:

- Allowing the contamination to dissipate or become ineffective through time and weathering.
- Neutralizing or destroying the contaminant.
- Physical removal by washing with water or solvents, with or without the aid of soap or other detergent.
- Shielding the contaminant, with dirt, for example. This is an expedient for preventing contact while time and nature accomplish the decontamination.

Time (decay), physical removal, and shielding are the methods also applicable to radioactive contamination.

In planning and carrying out decontamination operations the program should be based on materials, equipment, and resources which can reasonably be assumed to be available locally. If specialized materials are stocked they should specifically be to bridge a known local deficiency. Any supplementary resources which can be supplied from outside the community should be considered a bonus. The disruptions caused by an attack are almost impossible to predict. Community self-reliance should be the keystone of the organized plan.

Decontaminants

An important class of decontaminants comprises the common substances or natural influences such as time, air, earth, water, and fire.

Natural Effects

Biological agents are living organisms and tend to die off with time unless they are in a favorable environment with moisture, food, warmth, and other factors necessary for their survival. In addition, most biological organisms are very sensitive to the conditions of temperature and humidity -- and, particularly to the ultra-violet portion of sunlight. Adverse exposure to the elements -- air, sunlight, high temperature, low humidity -- is effective, in fact, against all biological agents except the spore forms of bacterial organisms.

It is generally assumed that in the vegetative form bacteria (as contrasted to the spore form) can persist for less than two hours during daytime and about eighteen hours at night. Since these short-lived bacteria are the most probable agents, outdoor decontamination is usually not called for unless the agent has been identified, either by laboratory tests or by the character of the disease, as one which forms spores or is otherwise known to be persistent.

The nonpersistent chemical agents, such as the volatile nerve agents (G-agents) would normally dissipate in a short time. They would present a problem only where there were splashes of liquid from a bomb or projectile or where the vapors might have been absorbed by foods. Except in these cases, aeration is an adequate decontaminating procedure.

The persistent, low-volatile, agents such as the liquid nerve agents (V-agents) and the blister gases present the principal chemical decontamination problem. Even these evaporate in time. The speed of evaporation and dissipation is enhanced by higher temperatures and wind. Thus, if it is possible to avoid the area or the use of contaminated objects for a reasonable length of time, decontamination may be unnecessary. Such periods might run from hours to a few days, depending on the degree of contamination and weather conditions. In cold weather the agents will persist for longer periods.

Water

Next to weathering, the most important natural decontaminant is water, used either to remove the agent, with or without soap or detergents to assist, or by boiling. One caution -- water used to wash away contamination becomes contaminated and must be disposed of accordingly. Boiling destroys most chemical agents and all biological agents. When it is feasible, boiling is one of the most generally desirable methods -- particularly for household use by individuals.

Earth and fire, the other natural decontaminants, would have relatively little application in civil defense BW/CW decontamination operations. Earth may be used to cover contamination temporarily to keep it out of contact with people while natural processes either dissipate or destroy the agent. This involves substantial effort with bulldozers and earth-moving equipment and usually is neither practical or necessary. Fire (burning over an area, or burning contaminated

materials) is a possibility, but usually has limited civil defense application. Burning material contaminated with chemical agents usually generates a downwind cloud hazard, and must be used with great care.

Chemical Decontaminants

These are preferred when they are available. Chemical decontaminants fall in two classes -- those which destroy or neutralize the agents, and those which simply assist in their removal.

The principal decontaminants which destroy or neutralize are:

- Chlorine-containing materials, such as calcium hypochlorite (HTH) and sodium hypochlorite solutions. Many household disinfectants available under various brand names -- Clorox, Purex, etc. -- are sodium hypochlorite solutions.
- Alkalies, such as caustic soda (lye) and sodium carbonate (washing soda, or soda ash).

The chlorine-containing materials, in proper concentrations, are effective against both biological and chemical agents. As solutions they are used to decontaminate surfaces, as in washing off sealed food containers; for decontaminating cotton fabrics by soaking or addition during the washing process; and for sterilizing water. Hypochlorite solutions have the disadvantage of corroding metals and so must be rinsed off thoroughly.

The hypochlorites -- calcium and sodium -- are the preferred decontaminants for blister gases and liquid nerve agents. For most such applications they are used as solutions but for vertical surfaces or porous surfaces a "whitewash" of calcium hypochlorite (HTH), hydrated lime, and water (called a "slurry") is more effective, since

it provides a longer contact time and more complete reaction.

The alkaline materials -- lye and washing soda -- are more effective than the chlorine-containing materials against the G-agent type of nerve gases. On the other hand, the alkaline decontaminants are somewhat less effective against the other chemical agents and the biological agents.

A variety of other materials - disinfectants - are of value in biological decontamination, but are not effective against chemical agents. Vapor disinfectants are needed when the contaminated object is a room or an enclosed space, an instrument, woolen clothing, leather goods, or some other object that cannot stand the more drastic decontamination with liquid chemicals.

Formaldehyde, used years ago in fumigation after cases of infectious diseases, is the vapor disinfectant most likely to be available in the community. While it is effective against biological agents it has disadvantages in that it requires conditions of reasonably high temperature and humidity, and it is injurious to some materials, particularly books and papers. In addition it necessitates an extensive airing period after use before occupation of the space is tolerable.

Other vapor or gaseous disinfectants such as ethylene oxide or in mixture with carbon dioxide (Carboxide) or fluorinated hydrocarbons, and methyl bromide have advantages in use but are not widely available in retail channels. When these can be obtained from medical or hospital supply houses or wholesale chemical distributors they should be used.

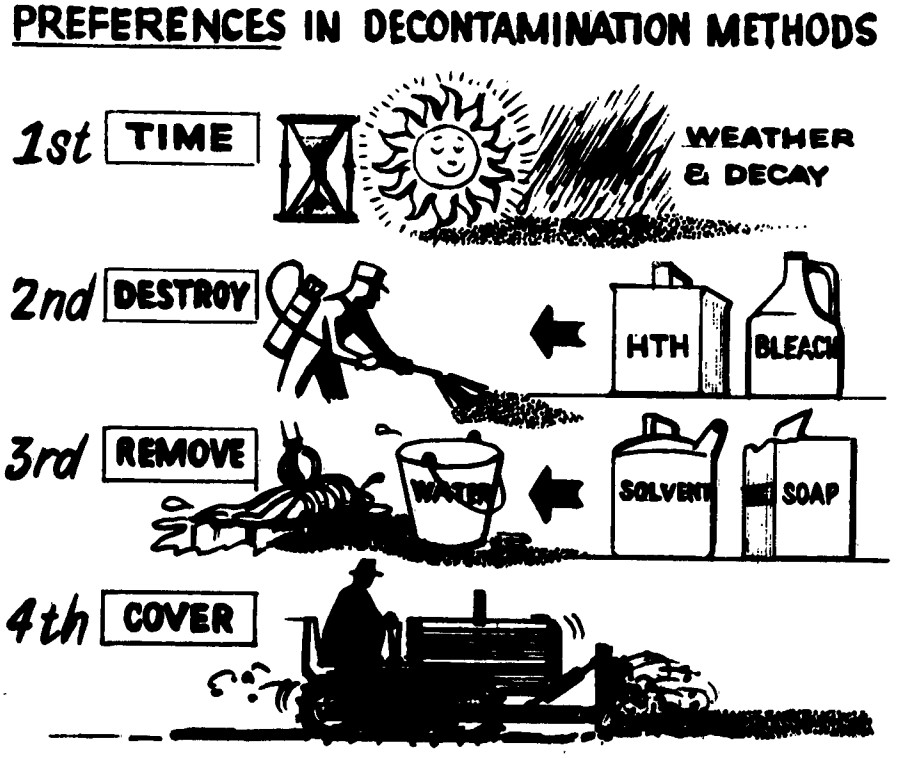
Miscellaneous liquid disinfectants, generally of the household type, include hydrogen peroxide, iodine preparations, and cresol preparations such as Lysol and Creolin.

Chemical decontaminants which physically remove the agents include soaps and other detergents, and organic solvents -- alcohol,

gasoline, kerosene, and perchlorethylene (non-combustible dry cleaning solvent). Particular caution must be exercised in using inflammable solvents because of the fire hazard.

An excellent detergent generally available in garages and wholesale auto supply outlets is Air Force Cleaner "gunk." Used in water solution, it is particularly effective in removing grease and oil which is holding the contaminant. It has the advantage of being non-corrosive to metals.

This type of decontamination - physical removal - is reasonably effective against both biological and chemical agents and is a principal method for radiological decontamination. Water with detergents, or the solvents mentioned, are much more effective than mere flushing with water. The same caution applies, however: the contaminant is removed, not destroyed, and provision must be made for safe disposal of the wash liquid.



Equipment and Facilities for Decontamination

Many commercial equipment items and facilities are adaptable to decontamination operations. Brushes, brooms, swabs, etc. are used in applying decontaminating solutions. Where boiling is applicable, equipment presents no problem but under disaster conditions the heat supply may be a limiting factor. Laundry facilities, both commercial and home types, are important resources if power, water, and heat are available.

On a larger scale, when area decontamination must be carried out despite its difficulty, various types of spray equipment such as orchard sprayers, tree sprayers, and even the common three-gallon sprayer are useful. Tank trucks and street flushing equipment can be used in flushing operations. Street sprinklers are sometimes employed to minimize secondary aerosol formation. However, this may increase the persistency of some biological agents.

In generating formaldehyde vapor for space disinfection, a variety of commercial insecticide sprayers or atomizers is available. These range from the small sprayers used by pest control operators for rooms and houses, up to the large fog dispersers normally used by mosquito control teams or in spraying park foliage. The latter would be useful, for example, in generating the large quantities of formaldehyde vapor needed in a warehouse decontamination.

Consideration should be given to using production-line auto washing facilities for decontaminating trucks and rescue equipment needed in recovery and rehabilitation operations.

Decontamination Applications

The Individual

The basic procedure for decontamination of the human body,

whether biological, chemical, or radiological agents are being dealt with, is removal and segregation of contaminated clothing; thorough bathing, preferably with hot water and plenty of soap; and reoutfitting with uncontaminated clothing. Once they understand how to perform these operations properly, individuals should be reasonably effective in decontaminating themselves in their homes. Facilities for decontaminating larger numbers can be established or improvised in gymnasiums, locker rooms, YMCA's and the like. Ideally, emergency control centers and key facilities should have permanent provision for personal decontamination at the entrances, in addition to being protected against biological and chemical agents by means of filters and proper ventilating systems.

Food

In many respects contaminated food and water supplies constitute the greatest post-attack hazard. For food packed in sealed containers the decontamination method involves cleaning the outer surface of the container. This is generally a washing process, using suitable additives in the case of biological or chemical decontamination, if possible, and plain washing, with or without detergents, for radioactive contamination. Fresh vegetables, meats, and other foods not in sealed containers present a more difficult problem. Selection of the proper method depends on the type of contamination. Washing, discarding outer layers, and cooking all have application in certain cases.

Water

Biological contamination can be destroyed by boiling or by the use of hypochlorite solutions. Thus, these methods are suitable for home use. However, there is no practical method for home treatment of water contaminated with chemical agents.

The normal filtration and chlorination processes in public water systems form a basis for both biological and chemical decontamination. Depending upon the agent present, such variations as increased chlorination, control of alkalinity, and increased holding time are needed. Note especially, however, that removal of V-type nerve agents requires additional materials and steps beyond those used in normal water purification.

Personal Belongings

Laundering or soaking in hypochlorite solutions are the preferred methods for treating cotton fabrics contaminated with either biological or chemical agents. Woolen fabrics require more careful treatment and less drastic laundering procedures. Dry cleaning or solvent extraction will remove chemical contamination but is not effective against biological agents. In any case, precautions must be taken to protect the workers and to safely dispose of contaminated solvents and wash water.

As an expedient, aeration outdoors will remove light chemical contamination. Aeration in the sun is also an expedient method for biological decontamination.

For cooking and eating utensils, boiling, washing with hot soapy water, and use of hypochlorite solutions are all applicable.

Interior Spaces

Decontamination of building interiors would be required only for biological agents. In addition to living and working areas, space decontamination might be applicable to quantities of supplies in warehouses or storage facilities. In spite of its disadvantages, formaldehyde vapor is the most effective material when it can be used. When this is impractical, for example, in the home, the only alternative is

washing exposed surfaces with a disinfectant such as household bleach, or with soap and water.

Chemical decontamination is concerned with liquid agents only, and these are not likely to penetrate into interior spaces. Thorough ventilation to sweep out any vapors should be sufficient.

Outdoor Areas

The heavy requirements in labor and supplies for large-scale decontamination of outdoor areas make such operations impractical. Decontamination of access routes and small areas around critical installations is a possibility.

Exposure and time will normally take care of biological contamination. Sprinkling or oiling of streets and roads to minimize secondary aerosol formation may be desirable.

Hypochlorite solutions or slurry are the usual materials for decontaminating V-agents and blister agents; for G-agents in liquid form, either alkali solutions or the hypochlorite mixtures are effective. Power sprayers, brushes, or brooms may be used for application.

Protecting the Decontamination Team

Adequate protection for workers engaged in decontamination operations is necessary. This includes respiratory protection, proper clothing, detection facilities, first aid, and decontamination after exposure.

Protective masks are preferred for both biological and chemical operations and are essential for chemical decontamination. For biological operations, dust respirators, preferably of the "absolute" type, can provide a satisfactory expedient.

The objective of protective clothing is to minimize exposure of skin areas to the agents. For biological operations, tightly buttoned coveralls

are satisfactory. A scarf may be used for additional protection at the neck and sleeves and trousers should be tied. For head covering, a tight-fitting cap is a minimum; an improvised hood is preferable. Rubber boots are desirable if liquid decontaminants are being used.

The requirements for individual protection in chemical decontamination operations are more stringent. Full protective masks are essential and impermeable clothing -- rubberized overalls, marine foul weather gear, etc. -- is desirable. If such items are not available, clothing of the type specified for biological operations is the next expedient. Particular care must be exercised to avoid contact with contaminated surfaces.

In chemical decontamination operations first aid materials should be available on the spot -- atropine for nerve gases and protective ointment if the contaminant is a blister gas. At least one individual in each decontamination group should be familiar with the symptoms of exposure to the agent being decontaminated and trained in the necessary first aid measures, including artificial respiration.

Chemical detection kits also are desirable, both to determine the specific areas of contamination and to make certain that decontamination has been complete. In addition, if radioactive fallout is present monitoring capabilities for this hazard should be provided as a means of protecting the workers. When the contamination includes both radioactive material and chemical or biological agents, radiation monitoring is an excellent technique for checking the effectiveness of the decontamination operations. Treatments sufficiently drastic to remove all radioactivity would usually be sufficient to remove chemical or biological agents.

After the completion of a decontamination operation, all workers should go through the personal decontamination process and all clothing and equipment involved also must be decontaminated.

Marking Contaminated Areas

Areas known to be contaminated should be marked off by placing the standard signs shown in Figure 13 . These are the standard markers

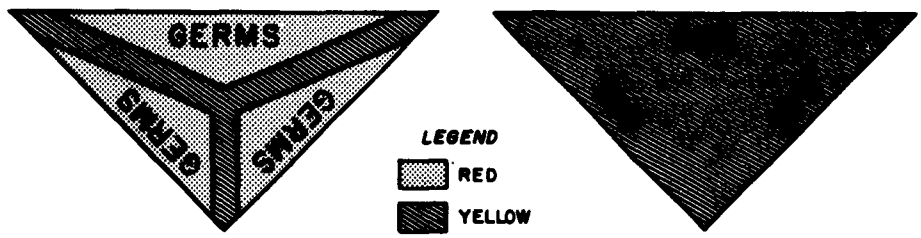


Figure 13 - Standard Contamination Markers

used by the U. S. military forces and are available through civil defense supply channels. The signs remain until the hazard has been eliminated, either by weathering or by decontamination.

Summary

Practical methods are known for dealing with biological and chemical contamination after attack. The necessary materials and equipment can be obtained, much of it from normal peacetime sources of supply.

The decision as to whether or not to decontaminate in a particular situation requires careful consideration of all the factors involved and must be a command decision by the local civil defense authority. The decision is essentially the result of a technical appraisal of the time and effort which must be expended in comparison to the consequences if decontamination is omitted or deferred.

It cannot be overemphasized that organized decontamination is hard work. It requires men, equipment, and materials that are significant resources for other phases of recovery. Yet it may be vital and of some

importance to implementing those other phases. Nevertheless, it should be carried out only when the advantages clearly outweigh the disadvantages.

CHAPTER II

PLANNING AND ORGANIZING FOR DECONTAMINATION

Up to this point the threat of biological and chemical attack has been outlined -- what these weapons can do and what are their limitations. The general principles of defense against them have been discussed, along with the part decontamination plays in a total BW/CW defense program. How to judge when and where to decontaminate -- and when not to decontaminate -- has been reviewed. The basic methods and materials used in decontamination operations in various situations have been summarized. In this chapter a basis is developed for planning and organizing to carry out these operations if they become necessary.

Conditions of location, size, and makeup of local communities, as well as the levels of their civil defense preparations, vary greatly. Because these recommendations are directed to all communities, they are designed around an "average" community where conditions are not necessarily identical with the one where this manual is being read. However, every community should be able to build into its civil defense preparations the principles and activities advanced here, while at the same time incorporating the variations in detail required by its own local conditions.

Steps in Planning

As an overview of the planning process, the following list gives a logical sequence of steps. These will then be discussed in more detail.

- Assign over-all responsibility.
- Identify the decontamination activities which must be planned

for -- both organized civil defense operations, and individual (home) measures.

- Identify the agencies, both governmental and private, which have resources and capabilities for each of these activities.
- Assign (or solicit the acceptance of) appropriate responsibilities.
- Locate or develop within these agencies knowledgeable people with the technical background necessary to assess the situation, determine what to do, and inform or supervise those who will carry out actual decontamination operations.
- Locate and inventory available resources of decontaminating supplies and equipment.
- Supplement these resources as feasible by procuring and storing specialized equipment -- particularly recommended are protective masks,[9] and detection equipment.
- Bring all these elements together into an operational plan so that each agency or group knows what it is to do, can make adequate preparations, and is ready to function in an emergency.

Where Should the Responsibilities be Placed?

The basic responsibility for decontamination operations, as for other civil defense operations, must necessarily rest with the civil defense director. But he discharges these responsibilities by delegation of authority to his various service chiefs. When major decontamination operations are involved, he will have to make the ultimate decisions on committing scarce resources, taking into account other competing demands.

As a part of the total BW/CW defense program, decontamination falls within the sphere of the civil defense unit charged with that defense. The

most common organizational placement is in a health service. It is frequently called the Emergency Health Service and is built around the local Health Department. This utilizes the professional and technical skills of the sanitary engineers, sanitarians, food inspection personnel and other environmental hygiene specialists generally on a health department staff. A community's public health programs are the nearest local peacetime counterpart to a BW/CW defense program.

It must be evident that the Health Service cannot actually perform all decontamination operations. Other city departments, and industrial and commercial establishments have important contributions to make. But the Health Department generally is the most logical agency to handle the planning and organizing mission, and to furnish technical advice and supervision during operations.

What Must be Planned For?

Once the responsibility has been assigned, the actual planning should be keyed around preparations for the following activities. These would be directed or carried out by governmental or private agencies on an organized basis.

Decontamination of People -- These would include members of the general public who have been exposed to BW or CW agents; casualties before admission to medical care; emergency command or operating personnel entering control centers; and individuals who have been engaged in decontamination operations.

Decontamination of Equipment Used in Rescue and Rehabilitation -- Particular emphasis must be placed on trucks, and other transportation and construction equipment, etc.

Salvage and Decontamination of Foodstuffs -- This would include retail and wholesale grocery stocks, supplies for mass feeding in welfare installations, and stocks in food processing plants.

Public Water Supplies -- If the public water system remains operable, effective decontamination would probably require only intensification of normal water treatment procedures such as chlorination, filtration, etc. If emergency water supplies are required, decontamination requires extra emphasis on detection, analysis, and purification steps, depending on the agent involved.

Interior Decontamination -- This applies primarily to biological attack and involves fumigation or disinfection of selected key facilities and installations.

Area Decontamination -- Decontamination of large areas is seldom feasible. It may be necessary, however, to decontaminate access routes or key areas surrounding central control and production facilities, to allow entry and restoration of operation.

Individual Home Decontamination Measures

Of equal, and perhaps greater, importance are decontamination measures which people can take in their homes, using materials at hand. Properly informed, individuals can take action to protect themselves much more quickly and effectively than any organized effort could be initiated. In addition this could utilize resources not otherwise available and take much of the load off the civil defense organized decontamination operations.

In the present state of knowledge and interest in civil defense it is unrealistic to expect that the general public can be trained effectively in decontamination procedures much in advance of an attack. On the other hand, simple and clear instructions as to steps to take after each probable form of attack can be developed in advance. They would cover decontamination and utilization of food and water, other sanitation and communicable disease control measures appropriate to the disaster environment, and advice on shelter protection and personal decontamination.

With these as a basis, specific plans should be developed with the information elements of the civil defense organization for passing them to the community members through all suitable communication media. The instructions would normally be prepared within the Health Service, which would also determine which to issue in a given situation. The Public Information Section should then assume the responsibility for their dissemination.

Where Are the Capabilities?

The following discussion of assignment of responsibilities presupposes a fairly complete municipal organization with capabilities in the various areas indicated. The problem is complicated if some services such as health services, water supply, fire and police protection, etc. are furnished by other agencies, such as the county. The functions must still be provided for but it is somewhat more difficult to arrange them with governmental authorities outside the particular jurisdiction. In the extreme case, none of these organized services may be available. It then becomes necessary to rely upon private individuals to plan and prepare for decontamination operations to the greatest degree possible. Community leaders such as doctors, veterinarians, the country farm agents, etc., executives of food-processing firms (e.g., dairies) are potential resources who are particularly qualified for the special demands of BW/CW decontamination.

In assigning detailed responsibilities, maximum consideration must be given to determining the agencies and private groups where the technical and operational capability, actual or potential, is most applicable to each part of the program.

It is just because an effective civil defense capability must be firmly rooted in normal community resources that the public health

authorities may be expected to carry a major share of the responsibility. Decontamination is basically an environmental health problem and the parts of the health organization concerned with this aspect constitute a major resource in the typical community. Depending upon the form of organization, these may include sanitary engineers, food and sanitation inspectors, air pollution control experts, insect and vector control groups, etc. Whether or not they are within the organizational structure of the health department, these people constitute a base on which much of the decontamination planning can be built. For example, food inspection personnel, whether located in the Health Department, Department of Sanitation, or other agency, can make a major contribution. They are familiar with the problems of contamination of food and have considerable knowledge of the handling of sanitation materials and operations. They can also be charged with the responsibility of determining when food supplies have been adequately decontaminated and are suitable for use.

The Water Department is the logical place for responsibility as far as public water supplies are concerned. As has been indicated, its planning and preparations primarily involve insuring that supplies and necessary materials are on hand; and that its own personnel are oriented and trained regarding special decontamination aspects that call for alteration of the normal purification process.

The Police Department can assist in locating, identifying, and marking contaminated areas, particularly if the patrol cars can be equipped with detection equipment. The police communication network can be a means of early reporting of chemical attacks observed. This system can also be an adjunct to other communications media in notifying individuals of steps to be taken after an attack. The department is a possible source of protective masks for use in decontamination operations.

The Fire Department is another possible source of protective masks. It constitutes a potential resource for decontamination operations involving flushing away the agents with water. Radiological defense units in many communities will utilize the fire department as a prime resource. It thus can be an important organization to use in assuring that radiological decontamination and chemical and biological decontamination are effectively coordinated in the local program.

The Highway or Street Department is a source for earthmoving equipment, trucks, and water sprinkling equipment.

The Department of Sanitation (or other agency concerned with refuse collection) can supply truck transportation and labor. It could be prepared to dispose of contaminated material, such as packing material from food packages, ruined food supplies, etc.

The Department of Parks and Grounds may be a source of spray equipment for use in area and warehouse decontamination.

The City Purchasing Office can assist in locating and inventorying supplies in municipal institutions, and in purchasing and storing specialized BW/CW defense equipment.

The above listing is by no means exhaustive. It does illustrate, however, the variety of places within local government where significant capabilities might be enlisted.

Help From Outside the Local Government

The individual responsible for the community's decontamination planning should establish contact with his opposite numbers at the state level, with regional representatives of the Food and Drug Administration and Public Health Service if they are nearby, and with the local county agent or representative of the Department of Agriculture. In many instances, he will thus obtain additional technical information and

guidance, and will learn the state plans for supplementing local resources, both technical and material. He should also establish contact with the corresponding officials in adjacent communities and jurisdictions, and with any military installations in the vicinity. This can lead, when circumstances are favorable, to area-wide integration of plans and mutual assistance.

Every effort should be made to enlist other resources available in the community -- industrial, commercial, educational -- to reinforce the local government's activities. Commercial laundries and dry cleaners, for example, have an important part to play in decontaminating clothing. Pest control operators, particularly those who specialize in fumigation, have personnel trained in handling toxic chemicals. Many have the gas masks which would be required in using formaldehyde in space decontamination, for instance. Another example is the preparation for decontamination of people. Since this is fundamentally a bathing process the potential resources are YMCA's, YWCA's, health clubs, country clubs, schools, some industrial establishments -- any facility which has a significant shower and locker room capability.

Industrial plants in the area -- especially those producing or using chemicals -- are another possible source of suppprt. Many have trained fire and police units; experienced truck drivers; maintenance units experienced in sanitation, plumbing, sewage, utilities, and equipment care. Some will have experienced food handlers trained in food sanitation; and some will have medical, technical, and scientific personnel capable of supervising decontamination operations. Similarly qualified people may be found in commercial food establishments.

Qualified People are the Key

The best plans and programs are useful only to the extent that there are qualified people selected, assigned, trained, and available to carry

out decontamination operations, as well as the other functions of BW/CW defense.

To the greatest extent possible the necessary key positions should be occupied by local governmental employees. The official charged with the decontamination program must be given the authority to select and arrange the emergency assignment of qualified government employees, and recruit and assign industrial, scientific, professional, and technical personnel, as key and support personnel, to the functional operations.

Many of the individuals required will be found in the public health, sanitation, transportation, fire, police, licensing, and inspection departments of the local government. They are the logical ones to plan and supervise the specific decontamination functions assigned to their departments. Also, their counterparts will be found in many industrial firms; from the medical and medical technician ranks, hospitals, trucking companies; and local communications, service and utilities firms. Additional personnel may be located from people with basic educational qualifications and/or hobby experience who can be interested in volunteering for specific or general assignments.

Another source of personnel for conducting planning and training has been established by OCD Memorandum No. 72-62. The use of non-obligated standby military reserve officers on a voluntary basis for civil defense service is now authorized. The program includes officers of all four military services; participants receive point credit toward retention and retirement. All these officers have received at least a basic training in BW/CW defense; many, particularly those in the Army Chemical Corps Reserve, will be found highly qualified. Procedural details can be obtained from the OCD Regional Office.

Training Needs

The people selected will have varying degrees of applicable technical background. However, all will need at least some

orientation or training in the particular problems of biological and chemical defense.

An ideal decontamination program would provide for a complete organization; with all individuals who would participate in decontamination operations fully trained and organized; with all necessary special equipment; and assured supplies of the necessary decontaminating materials. Those responsible for the community's civil defense will be well justified in planning out such a program, in particular since it will provide an excellent master chart that will alert them to local opportunities that may be overlooked otherwise.

The experienced local official will have no surprise or shock in recognizing that very few communities now provide him a realistic opportunity for creating a "ready-alert" BW/CW defense capability. However, the minimum objective that should be established is the selection and training of the key people.

This training effort should start with those individuals in the civil defense organization who would be responsible for determining the necessity and ordering and controlling decontamination operations. Within each of the governmental departments or commercial and industrial establishments having assigned responsibilities there should be assigned at least one person, and preferably several, trained in the specific operations involved. They should have the capability to instruct and direct or supervise those who would perform the actual decontamination operations after attack.

The material in this handbook can serve as the basis for such training. The first three chapters can be used to provide general orientation on the problem. Then there should be concentration on the particular operations in which the individual or group would be involved. Formal training sessions are desirable, at least in the initial orientation

stage. Where only one or two people would be involved in a particular operation, self-study, using selected portions of this handbook, can be assigned. Where a number of individuals will have similar functions, as in commercial laundries or personnel decontamination stations, group sessions should be planned.

Initiating the courses and identifying and furnishing the technical material should be the responsibility of the individual charged with decontamination planning. In organizing and conducting the courses the training elements of the local civil defense organization should give him assistance on techniques. Maximum use should be made of the technical assistance available from scientific and technical personnel in the local government and in local industrial and research firms. Scientific and technical societies such as the local medical society, the American Chemical Society, pharmacists' organizations, and trade groups are often willing to accept these advisory and training responsibilities as projects.

Locating the Materials and Equipment for Decontamination

Once the responsible people are designated and training started, the next phase is identifying and recording community resources of decontamination materials and equipment. Communities vary widely in this respect, but there are a surprising number of usually unrecognized sources in almost every one. Needs also vary: specifics should be based on assessment of activities that make sense in a particular locality. The particular supplies, manpower, and skills needed for carrying them out then can be developed from the technical information in Part II of this handbook.

Decontamination materials which should be considered include the following:

Calcium hypochlorite (HTH)

Sodium hypochlorite (household bleach)

Washing Soda (sal soda)

Caustic soda (lye)

Formaldehyde

Ethylene oxide mixtures (Carboxide, etc.)

Methyl bromide

Dry cleaning solvent

Possible sources for each are indicated in Chapter 6.

These inventories could well be taken by the city purchasing department where such an agency exists. If this is not feasible, it could be done by whatever element of the civil defense organization is responsible for the supply service. In any event the final records should include the sources, their locations, and the normal stock quantity maintained for each item. In larger cities it may be possible to enlist the assistance of trade associations, civic clubs, associations of purchasing agents, etc., in carrying out such a project.

Similarly, the availability of equipment adaptable to decontamination operations should be determined, as well as items for the protection of decontamination workers. Trucks, other transportation

equipment, and street washers and sprinklers are obvious. Other items of equipment include:

Bulldozers
Steam jennies
Power sprayers, high-pressure
Power sprayers, "fogging" type
Hand sprayers
Insecticide sprayers, aerosol type
Industrial gas masks
Industrial dust respirators
Rubberized clothing

Source information on materials and equipment should be kept on file at the civil defense operating headquarters, and in addition be made available to the municipal agencies which would be responsible for using them.

Special Equipment

Certain specialized items of equipment, particularly protective masks or expedient substitutes, and detection kits, are important to an effective decontamination operation. To the degree that funds can be made available, the first priority should be given to procurement of protective masks. The CD V-805, the CD V-800, and the military-type mask, CD V-860, can be procured through the OCD Contributions Program. These have all been evaluated and are known to be effective. Some Army-Navy surplus stores have stocks of various types of surplus military masks but their purchase is not recommended. Their quality and protective value cannot readily be checked for deterioration since their original manufacture.

Again depending upon the availability of funds, second priority should be given to procuring a limited number of Chemical Agent Detector Kits, CD V-810. These are needed in determining what areas or items are contaminated and in checking for completeness of decontamination after the operation has been completed. In the absence of detector kits, principal reliance must be placed on inspection for stains or apparent liquid contamination by chemical agents.

Coordinating and Documenting the Plans

As plans are developed they must be coordinated with the various other services within the civil defense organization such as public information, supply, communications, manpower, transportation, law and order, etc., to make certain that adequate support will be available in these areas.

Finally, the decontamination plans should be pulled together in the local civil defense planning documents. They may take the form of chapters, annexes, appendixes or operating procedures -- whatever format is appropriate and consistent with other parts of the local plan. The most important requirements are to make certain the information is readily available to those who must use it, and to keep it up to date.

Summary

To recapitulate, then, to plan for effective decontamination of people and things after exposure to biological and chemical agents, it is necessary to:

- Identify the particular places and things which may have to be decontaminated within the community.
- Identify the agencies and facilities, governmental and private, best qualified to plan and execute the various operations.

- Arrange for the orientation and training of key personnel in each of the responsible organizations and facilities.
- Locate sources of supply and determine normal stock levels for needed decontamination materials.
- Locate sources and arrange for needed equipment.
- Procure required specialized equipment or identify expedient substitutes.
- Coordinate plans with the various civil defense services.
- Continually review and update the plans as additional information is developed and additional resources are made available.

Part II - Decontamination Operations

Part II of this handbook is intended as a reference manual, to furnish specific details on decontaminating materials, methods, and techniques. With the general background of decontamination problems and principles provided by Chapter I of Part I and the suggested organization and planning factors in Chapter II, this section serves as a detailed basis for planning and training. Further, it is designed as a technical reference source in the actual conduct of decontamination operations.

To be of maximum utility to the working specialist, this section must be essentially complete in itself. This necessarily leads to some duplication of material previously presented.

Chapter III deals with general considerations, including decontamination of people and their personal possessions, and protective measures for decontamination workers. Chapter IV discusses decontaminating materials, with their characteristics and forms of application, and the principal types of equipment used. Finally, Chapter V covers the decontamination of various types of surfaces, materials, and objects. Under each subject the application to both biological and chemical agents is indicated.

Appendixes provide cross-reference tables for quickly locating appropriate materials and methods for various types of agents and situations; reference material on protective masks, detector kits and first aid; a glossary of terms used; and suggested references for further study.

CHAPTER III

GENERAL CONSIDERATIONS

Decontamination activities fall into two general categories:

- Individual measures which people take using their own resources, to decontaminate their own food and water supplies and their own living areas and essential items of use, and
- Major operations organized and directed by the civil defense authorities. These deal with decontamination of people in groups, water supply, stocks of food, rescue and rehabilitation equipment, and critical buildings and areas.

Home Measures

The most immediate requirement, once an attack has occurred or is suspected, is prompt self-help action on the part of individuals, using the means most readily available to them. If the public can quickly be told what to do via radio and all other suitable communications media, a major contribution can be made.

This can have the advantage of quick initiation, widespread application, and use of resources which would not otherwise be tapped. It conserves the energies of the civil defense organization for the larger aspects of organized decontamination.

Many of the measures described in the next two chapters are available and effective in home situations. In particular, they include, in various combinations:

- Boiling
- Proper preparation of food

- Aeration
- Laundering
- Use of household bleach
- Scrubbing with soap or detergents and water.

But effective use is contingent on advance preparation by the health and information elements of the civil defense organization. Sets of simple and clear instructions should be prepared for the various situations and agents considered possible. These should embody the appropriate methods and precautions and take into account personal decontamination (bathing, etc.) food, water, utensils, clothing, and bedding as a minimum.

The information office should be prepared to issue the proper instructions, as determined by the health authorities, in an emergency situation. Either regular radio or Conelrad is the most probable channel. Television is a possibility. Others, depending on the situation, include sound trucks and block wardens or other house-to-house dissemination. Some situations might permit the use of newspapers or "flyers" -- at least for follow-up.

Organized Operations

To review, the conditions which must exist before decontamination is undertaken include the following:

a. The area or object is actually contaminated with toxic chemical agents or suspected to be contaminated with biological agents.

b. There is a necessity for decontamination -- that is, it is not feasible to avoid or defer the use of the area or object until the contamination has disappeared by natural means.

c. There must be suitable and practical means of decontamination available in terms of supplies, equipment, and labor.

d. The time required for the planned decontamination must be less than the time in which the contamination would dissipate or the time which use of the object or area could be avoided.

e. The urgency of the situation is such that decontamination has a sufficient priority over other potential uses of the resources.

On the other hand, if decontamination is needed, it should not be omitted simply because the recommended methods are not feasible. Any expedient means at least decreases the hazards, even if it does not totally eliminate them.

Decontamination of Individuals

The subjects of decontamination for individuals and of personal decontamination facilities are taken up at this point rather than later. The procedures and materials are quite different from decontamination methods for other situations. Further, personnel decontamination is an important element in the protection of decontamination workers.

Immediate or Emergency Decontamination

This is a matter of concern only with chemical agents. Because of the slow action of biological agents masking or other respiratory protection is sufficient until a more complete decontamination can be carried out.

In removing nerve agents of both types from any part of the body, immediate and thorough action is necessary since these are quickly absorbed and a small amount can cause death. Quick action is also necessary in removing liquid blister agents from the skin (within three to five minutes) to prevent later blistering. This emergency decontamination would be needed by people caught in an

actual spray attack. It would also be needed by decontamination workers or other persons who accidently come in contact with liquid chemical agents remaining on surfaces after an attack.

(page 61)

Protective Ointment, CD V-820, may be used for immediate decontamination of liquid nerve agents and blister agents in contact with the skin. In absence of protective ointment the agent may be pinch blotted from the skin and then flushed with water. Soap and water, if available, are more effective.

Preventive Decontamination

This type of personal decontamination is applicable to biological contamination, and to liquid chemical agents when skin contact has been avoided but the agent has been picked up on the clothing. Its purpose is to prevent carrying contamination into a shelter or other protected area, or to eliminate a continuing hazard once the individual has unmasked or abandoned whatever respiratory protection he may have. In the case of chemical agents it is essential in order to avoid exposure caused by the agent soaking or diffusing through the clothing and eventually being absorbed by the skin.

The same general principles apply to both biological and chemical decontamination:

- Removal and segregation of contaminated clothing.
- Thorough scrubbing of the body with soap and water.
- Monitoring for remaining radiological contamination, if applicable.
- Donning uncontaminated clothing.

Organized Decontamination Operations

The application of these principles to decontamination of a few people in the home is relatively straightforward. But handling numbers of people is a more difficult problem. Facilities and preparations for decontamination of multiple individuals must be arranged for the following situations:

a. Decontamination of people entering shelters or protected spaces, to avoid carrying the contamination inside. This may also include decontamination of casualties before admitting to medical care.

b. Decontamination of workers after exposure during decontamination operations.

c. Decontamination of civil defense workers who must leave and reenter control and communication centers.

Personnel Decontamination Facilities

Shower facilities for decontamination purposes are included in Federal Emergency Control Centers and in state and local control centers constructed with matching funds. These also include air filtration equipment to ensure a safe working environment.

Figure 14 is an example of a military decontamination station made by conversion of an existing building. It should be noted that it provides for a traffic pattern which prevents contaminated clothing and equipment from being introduced into the clean areas past the shower facility.

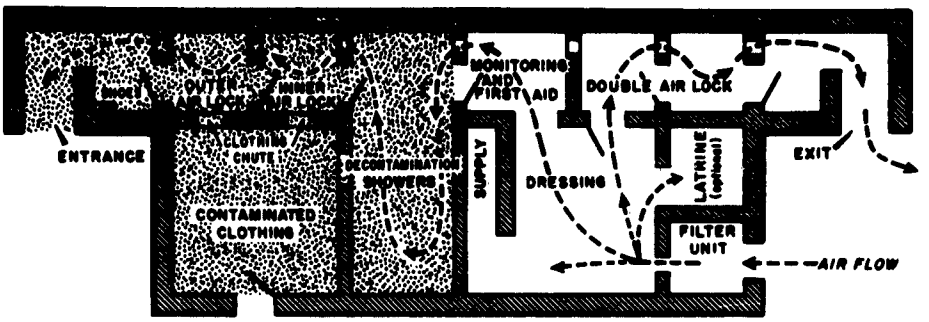


Figure 14 - Military Decontamination Station

This represents an ideal layout. In many instances it will be necessary to improvise emergency decontamination centers for the general public as well as at fallout shelter entrances. The level of preparation may range all the way from using locker and shower rooms in schools or industrial plants as excellent decontamination facilities to the use of buckets of water in the open.

Locker and shower rooms such as those found in school gymnasiums, YMCA's, YWCA's, country clubs, and many industrial facilities are generally adaptable to personnel decontamination provided two precautions are observed. First, arrangements must be made for safe storage and handling of contaminated clothing until it can be decontaminated. This requires essentially tight containers such as garbage cans, plastic bags, or even heavy laundry bags. The object here is to prevent the generation of secondary aerosols as a threat to handlers of the clothing. The other requirement is the

provision of a clean area for donning uncontaminated clothing after the showering. An exit from the shower room to this clean area must be provided which will not require passing through the contaminated undressing area.

Procedures

The procedures used and the degree of decontamination achieved must necessarily vary according to the facilities available. The optimum is represented by the procedure prescribed by the military for a fixed decontamination station and described below. It is designed to take care of the heaviest levels of contamination. This might be approached in the decontamination facilities for an emergency control center but it would be necessary to accept a much lower standard in an improvised civilian station.

The personal decontamination actions and actions of assistants in this situation are shown in Table 3 . Each area of the decontamination station is supervised by the number of assistants considered necessary for the number of people using it at one time. Assistants and workers handling contaminated clothing and equipment wear the best protective clothing available, rubber gloves and rubber aprons if possible. Outside the station brushes and pails of soapy water (hot, if possible) and clear water are provided for decontaminating boots and shoes. Throughout the station containers are provided for various items of clothing as they are removed.

Table 3

Personal Decontamination Actions

Personal Actions	Actions of Assistants
Decontaminate shoes or boots	Supervise and inspect
Have masks decontaminated	Decontaminate masks
Remove shoes; place in containers	
Remove outer clothing; place in containers or as directed	Supervise and assist in removal; control traffic
Remove gloves, socks, and drawers; place in containers or as directed	Supervise removal; control traffic
Take a DEEP BREATH AND HOLD IT.	
Immediately remove mask and undershirt; place in containers or as directed	Supervise removal; control traffic
Quickly step under shower and, still HOLDING BREATH, flush upper part of body beginning with head	Supervise flushing and showering procedures as necessary
RESUME BREATHING	
Thoroughly bathe entire body -- using plenty of soap and water -- particularly hairy portions and under fingernails.	
Be monitored for radioactive contamination (If necessary repeat showering and monitoring)	Monitor
Dry body	
Receive necessary first aid	Assist as necessary
Receive and put on uncontaminated clothing	Issue clothing

At the entrance of the station the personnel decontaminate their shoes by scrubbing them twice with hot soapy water and then with rinsing in clear water. Following this, if they are masked, the exposed portions of their masks are decontaminated as necessary by station assistants. Assistants, using a cloth or sponge, wipe exposed portions of protective masks with hot soapy water and then with clear water. (Water should not be allowed to enter the mask canister, or wet the filter pads of the CD V-805 mask.)

The men remove their shoes just prior to entering the station or the first air lock. Outer clothing is removed as they progress through the airlocks or designated areas. In the undressing area, they remove clothing in the following order: gloves, socks, and drawers. All items of clothing are deposited in designated containers. They then move on to the showers and while holding their breath, remove the mask and undershirt, put them in containers and immediately enter the shower.

Starting with the head, they flush the upper part of the body with water as thoroughly as possible before breathing is resumed. (For liquid nerve agent contamination, flush with copious quantities of cold water.) The entire body is then bathed with plenty of soap and warm water using the following procedures:

a. Scrub hands and under fingernails

b. Thoroughly wash hair and other hairy portions of the body.

c. Soap body well.

d. Rinse

e. Resoap body

f. Rinse

After leaving the shower the men are monitored for radioactive contamination. If contamination is present, they reshower and are remonitored. They then dry bodies and receive medical treatment or first aid if required, and proceed to the dressing area where they don clean clothing.

The following additional procedures are used if biological contamination is involved.

a. Any minor cuts or abrasions should be treated by ordinary first aid measures. Tincture of iodine or other disinfectant is suitable.

b. If available, antiseptic soaps such as those containing hexachloraphene should be used.

c. The body surface should be scrubbed vigorously to remove organisms from the skin.

d. When the mask is removed just before showering, the head should be held back to prevent runoff from passing over the eyes, nose, and mouth.

Relation to Radiological Decontamination

Current policy on radiological monitoring and decontamination for personnel entering emergency control centers is as follows: (To the degree possible it would also apply to group shelters.)

a. All entering individuals will be monitored for radioactive contamination.

b. If significant contamination is shown, the individual should brush off his clothes with particular attention to brushing dust from the hair and, if possible, wash hands, face, and all exposed skin areas.

c. If remonitoring shows that contamination is still present, the individual must shower and put on uncontaminated clothing.

However, if chemical or biological contamination is involved, monitoring is not applicable, and there should be no dusting or brushing. Such action could generate secondary aerosols, and biological or chemical aerosols are dangerous in far smaller quantities than radioactive dust. Consequently, if chemical or biological contamination is involved, individuals should proceed immediately to the showering operation.

Protection of Decontamination Workers

All practicable steps must be taken to protect workers in organized decontamination operations from becoming casualties themselves. In both chemical and biological decontamination the major objectives are to avoid inhaling secondary aerosols raised during operations, avoid any contact with liquid chemical agents on surfaces and minimize exposure of the skin to vapors of chemical agents.

Respiratory Protection

Protective masks are essential in decontamination operations after chemical attack and desirable for biological decontamination. They are needed for biological operations involving vapor-type materials such as formaldehyde, ethylene oxide, or methyl bromide. For biological operations using disinfectant solutions, scrubbing, or laundering, high quality dust respirators are adequate to prevent inhalation of any secondary aerosols generated.

The preferred masks for this service are the Organizational Mask, CD V-800; the military-type, CD V-860; and the Civilian Protective Mask, CD V-805, in that order. These are effective against both chemical agents and vapor-type decontaminating materials.

The next alternative is found in certain of the industrial type gas masks used by firemen, police, industrial workers and pest control operators. These are equipped with various types of color-coded canisters, depending on the gases they are designed to protect against.

The commercial designations for the types which are applicable in BW/CW defense and decontamination include:

- Organic Vapor - Acid Gases (Yellow canister)
- All-Service (Red canister)
- Organic Vapor-Acid Gases-Ammonia (Brown canister)

  These three furnish adequate respiratory protection against the nerve agents and blister agents as well as the vapor decontaminants - formaldehyde, ethylene oxide and its mixtures, and methyl bromide. The extra chemicals put in the last two limit the amount of activated charcoal that can be contained. Thus, under the same conditions of agent concentration they would give full protection for a shorter time than the "Organic Vapor - Acid Gases" canister.

- Organic Vapor (Black canister)

  This type is adequate for exposure to the vapor decontaminants. Although it provides considerable protection against chemical warfare agents, it is not recommended for this use unless there is no other alternative.

Most industrial masks contain filters to remove aerosol particles. All "All-Service" (red canister) masks carry filters. Filters on the other types are indicated by a black or white band around the canister near the top. Information as to the type of filter is usually shown on the Bureau of Mines approval label affixed to the canister. The best

protection -- comparable to the OCD masks -- is provided by the "Radiological" type. It removes 99.95% of particles in the 0.3 micron range. The next lower level is the "Full Smoke," which removes at least 99.6%. Finally, the "Light Smoke" class is still less effective, but gives a significant degree of protection against aerosols.

WARNING -- The masks described do not manufacture oxygen and do not provide protection in oxygen-deficient atmospheres such as are found in fires or heavy volumes of certain industrial gases such as carbon monoxide and ammonia. When fighting fires or heavy volumes of released industrial gases, the civil defense and industrial masks (other than "All-Service!") must not be used. Instead, self-contained breathing apparatus, like oxygen masks, or masks specifically designed for gases originating from fires or industrial gases should be used. It is essential that civil defense workers be aware of this hazard when fighting fires or chemicals other than war gases. The protective masks are efficient against war gases and BW agents only.

Certain classes of dust respirators are acceptable substitutes for masks in biological decontamination operations only. Tests on industrial dust respirators have shown efficiences as high as 97.0 to 99.9% in removing particles in the 1 to 5 micron range. The manufacturer's literature should be consulted to evaluate particular respirators. The lower range is characteristic of Bureau of Mines approved respirators for "dusts not more toxic than lead," and for "dusts, mists, and metal fumes." The most effective are those variously designated as "ultra" or "absolute" filters.

Modern surgical masks, either glass fiber and gauze or molded glass fiber, are 90 to 99% effective against 1 to 5 micron particles. Ordinary gauze surgical masks are relatively ineffective.

WARNING -- Neither dust respirators nor surgical masks protect against chemical agents, or against the vapor-type decontaminants when used for interior (space) decontamination of biological agents.

Protective Clothing

Impermeable protective clothing should be worn in operations involving liquid chemical agents on surfaces. Several types of impermeable clothing used by workers in chemical plants are available from safety supply companies. Marine foul-weather gear and some types of waterproof clothing worn by firemen and utilities workers also are suitable.

For most decontamination operations ordinary clothing, preferably of several thicknesses, gives reasonable protection. Maximum protection, using commonly available items, would include the following:

- One-piece coveralls worn over normal outer clothing and buttoned over an improvised scarf at the neck.
- Rubber or neoprene gloves, if liquid decontaminants are being used. Otherwise, cotton gloves are satisfactory. Cuffs of the coveralls should be pulled over the gloves and tied securely at the wrists.
- Rubber boots, if liquid chemical agents are involved or in using slurries or sprays. Trouser legs should be rolled over the boots and tied at the ankles. Lacking rubber boots, heavy leather shoes or boots could be used. Treating leather with shoe dubbing or waterproofing compound, or even grease, will reduce the rate of absorption of liquid chemical agents.
- Tight fitting cap, preferably with an improvised hood to minimize contact of agents with the neck and penetration into the clothing.

At the completion of decontamination operations, workers should discard contaminated clothing for later decontamination, and shower thoroughly, following as far as possible the personnel decontamination procedures discussed above.

First Aid

Each group performing decontamination operations on chemical agents should have at least one person trained in recognition of symptoms, first aid measures for chemical agent exposure, and safety precautions for the decontaminating materials used. Necessary treatment materials should be available. Depending on the agent, these include atropine in self-injection devices for the nerve agents; Protective Ointment CD V-820, for blister agents; household bleach solution for decontaminating accidental V-agent contamination on the skin; and washing soda solution, if G-agent liquid contamination is involved. Appendix G is devoted to detailed first aid procedures.

To summarize -- protection of the decontamination worker requires:

- Preventing inhalation of contaminants
- Minimizing deposition on the skin
- Thorough cleanup of both person and clothing at the conclusion of operations.

Detection of Contamination

Whenever possible, the nature and extent of contamination should be known so that the best decontamination procedure may be used. The Chemical Agent Detector Kit, CD V-810, Water Testing and Screening Kit, CD V-902, and Food Testing and Screening Kit, CD V-903, are available for this purpose for chemical agents. (Appendixes D, E, and F.)

The CD V-810 kit is used to take samples of air immediately above contaminated surfaces to see if the air contains vapors of the agent. It is also used to determine completeness of decontamination. Metal and other nonabsorbent materials offer no particular problem in testing for residual contamination; however, porous materials, such as wood and fabrics, may retain contamination which is not immediately detected outside the material. The vapors of the contaminant contained within the pores may be released too slowly to indicate a positive test above or on the surface. In testing such material, vapors may be entrapped by setting an open can, drum, or similar container upside down on the surface of the porous material for a period of time ranging from five minutes to one hour. A small hole may then be punched or bored in the bottom of the container and the vapors sampled and tested by means of the detector kit.

The water and food testing kits are discussed in the Chapter V in connection with decontamination operations. (Pages 76 and 72).

At the present time there is no rapid detection device for biological agents. Decontamination must proceed on an assumption that the objects or areas are contaminated if it is known that an attack has occurred. Similarly, reliance must be placed upon careful conduct of decontamination operations to give maximum assurance of complete decontamination.

Equipment for Decontamination

As will be seen in Chapter V, on specific applications, decontamination operations generally involve the application of liquid or slurry decontaminants, or flushing, or washing. Depending upon the scale and type of operation, equipment may vary from brooms, brushes, and swabs up to power-driven spray apparatus, street sprinklers, and the like.

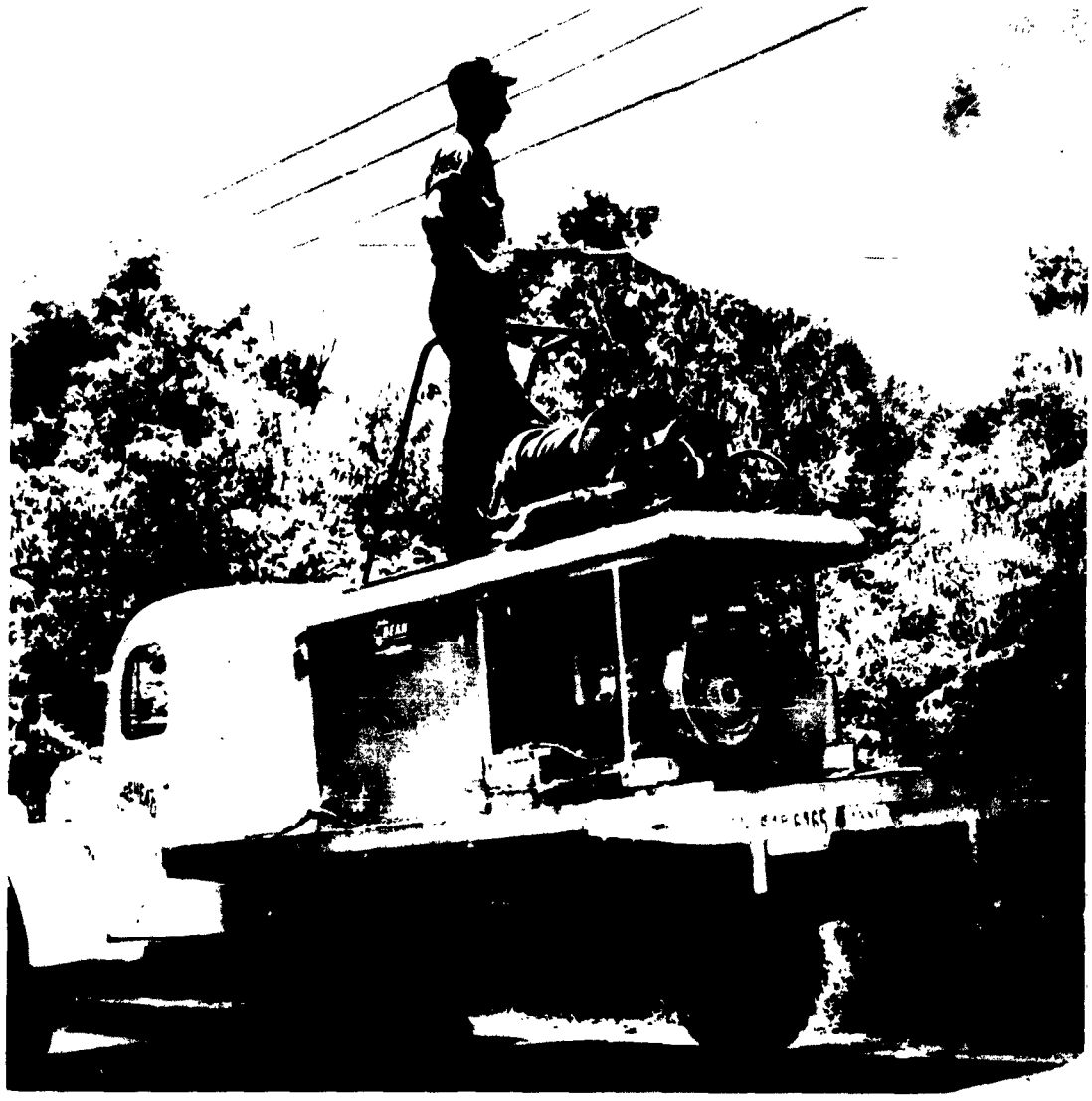


Fig. 15 . Typical High Pressure Power Sprayer

Figure 15 shows a typical power-driven sprayer of the type used in orchards. This is used primarily to spray water, slurry, and other decontaminants such as hypochlorite solution or detergent solutions. For small scale operations, garden sprayers are suitable.

Fig. 16. Representative Small-scale Disseminators

Insecticide sprayers (vapor or aerosol type) are used in disseminating formaldehyde in decontaminating enclosed spaces. These range from the small units used by pest control operators shown in Figure 16 to the large "fogging" type used in mosquito control. These latter are required for large spaces such as warehouses.

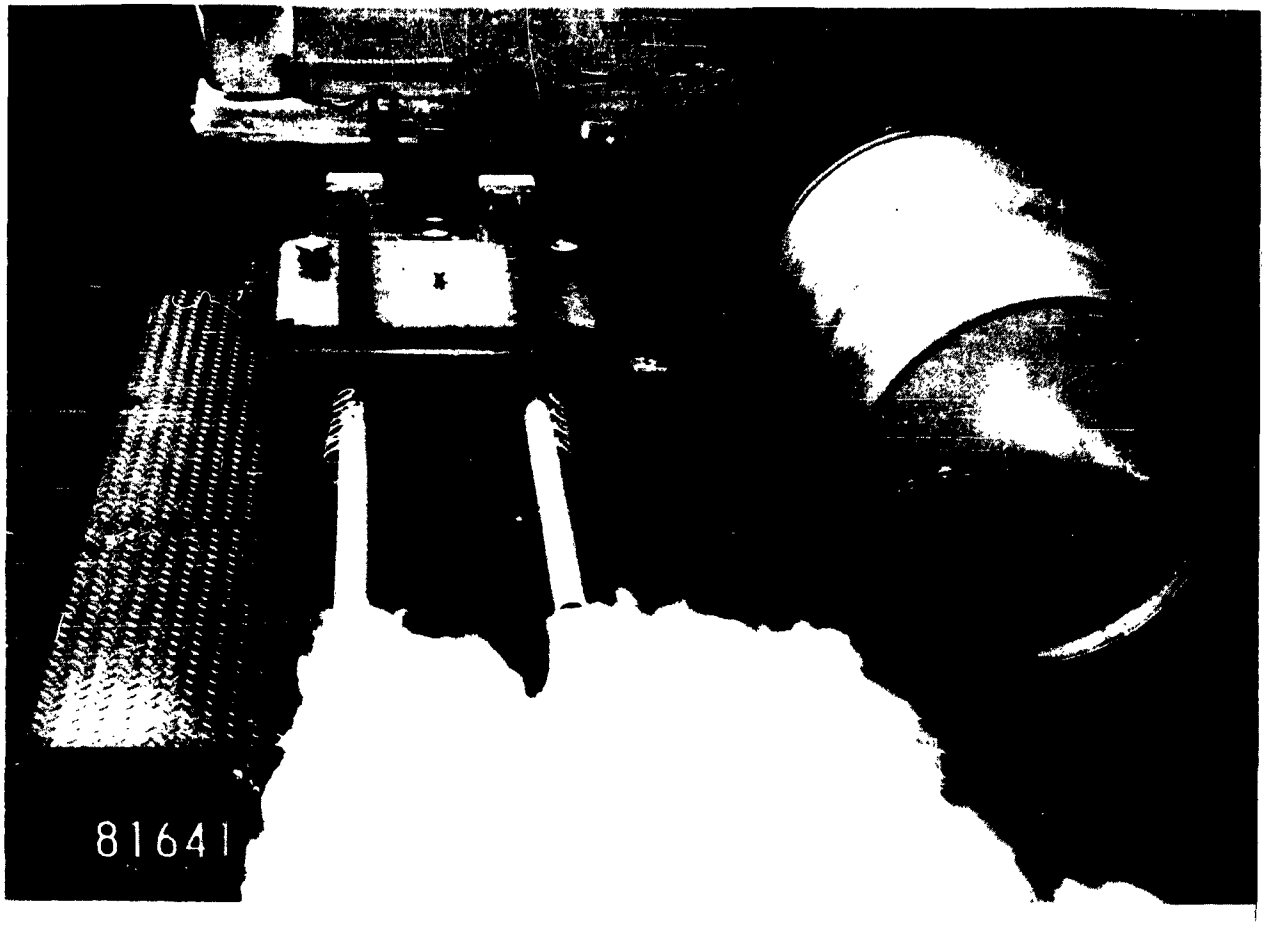


Fig. 17 . Typical Large-scale Fog Machine

Tank trucks, street flushers, and street sprinklers are of value in some situations. particularly in operations involving radiological decontamination as well as biological or chemical.

Marking Contaminated Areas

Contaminated areas should be posted with the standard markers shown on page 24a. They are available through the civil defense supply channels and are similar to those used by U. S. military forces.

The markers are placed with the long dimension horizontal and the colored side facing away from the contamination. The back (white) side is marked with the date the area was contaminated or contamination discovered; the agent, if known; and any other useful information. Spacing of the markers will depend on the surroundings, but it should be possible to see from one to the next.

The markers must remain until the hazard has been eliminated, either by weathering or by decontamination.

CHAPTER IV

DECONTAMINANTS

Decontaminants fall into two general classes. Natural decontaminants include weather, water, earth, fire, and in the case of biological agents, dry heat. Chemical decontaminants include a number of materials which are effective against both biological and chemical agents and others which are effective against biological agents only.

Natural Decontaminants

Weather

Dehydration and exposure to sunlight are the principal means by which weather kills micro-organisms in biological decontamination. Weathering causes gradual evaporation and decomposition in the case of chemical agents.

Weathering is the simplest method of decontamination and is utilized whenever possible. Contaminated terrain that is not of vital importance is posted with standard contamination markers and left to be decontaminated by weathering. However, lack of time, unfavorable weather conditions, or proximity of contamination to unprotected personnel may require use of a faster method.

The effective elements of weather include, air, temperature, humidity and precipitation, and sunlight.

Air. Aeration promotes decontamination of chemical agents. High winds rapidly disperse their vapors.

Temperature. In general, atmospheric temperatures below 100° F do not seriously affect biological agents. At temperatures below 40° F (normal refrigerator range) reproduction and growth may be slowed down, but survival time tends to increase.

High temperature speeds up the change of liquid to vapor (evaporation) and increases the dissipation of chemical agents into the air. The persistency

of liquid chemical agents on the ground increases as the surrounding temperature decreases.

Humidity and Precipitation. The rate at which a biological agent dries out or dehydrates is dependent upon the moisture content of the air. Although some possible biological agents (bacterial spores) are not affected by reduced humidity, periods of dry weather aid in reducing most types of biological contamination within an area. Rainfall can wash off many micro-organisms. In addition, the wetting of the terrain helps prevent the formation of secondary aeresols.

Moisture tends to hydrolyze chemical agents, but most hydrolyze slowly. In addition to causing some hydrolysis, rain adds decontamination by mechanically removing the agents. It may, however, cause the concentration of chemical agents in drainage areas, a contamination hazard.

Sunlight. The ultraviolet radiation in sunlight has a germicidal effect on biological agents. However, the micro-organism must be directly exposed to sunlight and not protected by layers of dirt, oil, water, or vegetation. Direct exposure to sunlight for a day will reduce contamination from these agents, other than bacterial spores, to a safe level. Spores, being resistant to adverse conditions, will survive for longer periods of time.

Bright sunlight helps remove chemical contamination. Even in cold weather the direct rays of the sun warm surfaces above the air temperature and hasten the evaporation and decomposition of the agents.

Water

Flowing water is used to remove mechanically surface contamination by both biological agents and chemical agents. Hot water is a better decontaminant than cold, and addition of soap produces even more effectiveness by improving the wetting power of the water.

Flushing. Flushing a contaminated surface with water removes much of the biological agent. The effectiveness of this action is increased

when high water pressure is used, contact time is increased, temperature of the water is raised, and soap or detergent is added to the water. If live steam is used in flushing the surface the heat involved kills many of the organisms.

For chemical contamination also, high pressure application produces a better cleansing action than low pressure. If the contaminated surface is porous or painted, flushing serves to remove the surface contaminant but does not decontaminate a liquid agent which has penetrated the surface.

Boiling. Biological decontamination of many items, including small amounts of drinking water, may be accomplished by boiling for a minimum of 15 minutes. This time must be doubled when the boiling is being done at high altitudes. Autoclaving (with a pressure cooker device) at 250° F for 15 minutes is recommended if available.

Soaking chemically contaminated items in boiling water is an excellent means of decontamination. Soaking in cold water is less effective since cold water reacts slowly with most chemical agents. If hot or boiling water is harmful to the equipment to be decontaminated, warm water (up to 140° F) may be used but may not always produce complete decontamination.

Water used for flushing off biological or chemical agents is contaminated and must not be disposed of in areas where it might flow or be washed into streams or other bodies of water or where it may contaminate ground water used as a water supply source. The disposal area must be selected with consideration to the hazards to the population. Areas so used should either be decontaminated with calcium hypochlorite (p. 54) or marked with the standard contamination markers.

Earth

Burying biological contamination is an expedient decontamination measure. It would have application in disposal of condemned food stocks

and other materials, and in the disposal of unexploded or contaminated munitions.

Earth is used to seal in chemical contamination or as an absorbent for liquid contamination. Covering an affected area with about 4 inches of earth is protection as long as the earth is not stirred and the chemical agent exposed again. Such an area may be then traversed safely. In the absence of better absorbents earth can be used for removing liquid contamination from equipment or surfaces. Earth so used becomes contaminated and should be covered or buried.

Fire and Heat

Fire may be used as a biological decontaminant in the disposal of condemned combustible materials. Dry heat in an oven at 335° F for two to three hours will decontaminate appropriate items of equipment.

Heat vaporizes chemical agents; therefore, it may be used to drive off liquid contamination. Hot air blowing over a contaminated surface decontaminates the surface by evaporating the agent. Steam, especially in high pressure application, both hydrolyzes and evaporates toxic chemical agents and flushes them from surfaces. Care must be taken not to overheat and damage materiel that will not withstand high temperature. Contaminated electrical instruments (radios, generators, and motors) may be decontaminated by continued operation of the instruments if sufficient heat is liberated during operation to vaporize the agent.

Fire destroys or vaporizes liquid chemical agents. Some agents, such as as mustard, are combustible and upon burning are converted into relatively harmless products. Used with care, fire is a rapid, simple, and effective means of decontaminating terrain or noncombustible material. When such areas are to be decontaminated by fire, fuel (diesel oil, gasoline, kerosene, or other petroleum products) is first poured on them and then set afire. Flame throwers, such as are used in weed control, may be used in decontamination by fire.

Fire must be used with caution when large contaminated areas are burned. A dangerous concentration of blister agent vapors may exist downwind to a distance of as much as 1300 yards. Likewise, a dangerous concentration of nerve agent vapors may exist as far as ten miles downwind of the burned area during inversion conditions. Permission to use fire must be obtained from the Civil Defense Director, and adjacent personnel must be warned when the burning is to take place.

Chemical Decontaminants

A number of chemical materials (soaps and detergents are included in this category) are effective against both biological and chemical contamination. Others, particularly vapor and liquid disinfectants, are used only for biological decontamination.

Calcium Hypochlorite (HTH)

High-test calcium hypochlorite is commercially available as a stable, white, water-soluble material in granular or tablet form. Typical trade names are HTH, Pittchlor, and Perchloron. The initials HTH have come into use as a general abbreviation for "high-test hypochlorite" and ~~is~~ are so used in this handbook. HTH contains a minimum of 70 percent available chlorine and is effective against both chemical and biological agents.

HTH is normally packaged in 5 lb. cans and 100 lb. drums. Some retail outlets stock the material in smaller containers for use in dairy, household, or swimming pool sanitation.

Action. Although HTH can be used against biological agents in dry form, it is most effective when applied in solution or as a slurry. A slurry is a mixture of HTH, hydrated lime and water of about the consistency of whitewash. In solution or suspension the chlorine is released faster than when dry, to destroy bacterial spores and other resistant micro-organisms. These forms also serve to suppress secondary aerosols.

HTH destroys chemical agents by converting them into harmless or less toxic compounds. Dry HTH reacts violently with liquid mustard and the reaction usually produces sufficient heat to cause a flame. It may be applied directly to surfaces contaminated with liquid mustard when there is no objection to the resulting vapors of mustard produced by burning and if fire would not damage the surface. It does not react with liquid chemical agents after they are absorbed in the ground or in other porous materials, since it does not come in direct contact with the agents. However, as long as it retains its chlorine it serves to seal in the vapors of the chemical agent or to neutralize them as they rise from the contaminated surface.

Preparation and Use. Recommended compositions for the various forms of application -- solutions, slurries, and dry mix -- are given below.

Solutions - For biological agents on horizontal surfaces, solution strength should be 0.6 to 1 lb. per gallon of water (giving approximately 5 percent available chlorine). For chemical agents on horizontal surfaces the strength should be doubled, 1-1/4 to 2 lb. per gallon of water.

Solutions of HTH can be used interchangeably with the sodium hypochlorite (household bleach) solutions discussed later. For ready reference, the proportions for two common strengths in various quantities are as follows:

CALCIUM HYPOCHLORITE SOLUTIONS

Water	HTH (granular) to give 5% Available Chlorine (50,000 ppm.)[1]	HTH (granular) to give 0.2% Available Chlorine (2,000 ppm.)[2]
40 gal.	25 lb.	1 lb.
5 gal.	3 lb.	2 oz. (5 tablespoons)
1 gal.	10 oz. (1-1/2 cups)	1/2 oz. (1 tablespoon)
1 qt.	2-1/2 oz. (6 tablespoons)	1/10 oz. (1 teaspoon)

Notes: 1. Equivalent to household bleach solution.
2. Strength used for biological decontamination of food packages, cotton fabrics, and disinfecting surfaces in building interiors.

Slurries. For vertical surfaces it is desirable to add hydrated (slaked) lime to form a thickened material which will cling to the surface and remain in contact with the contaminant for a longer time. This is referred to as "slurry" throughout this handbook. Addition of lime also decreases the corrosiveness, an essential if metal spray equipment is used. Sugar is added to stabilize the suspension.

Depending on the method of application, the proportions should be as follows:

	Manual Application (Brushes or Brooms)	Sprayer
HTH	3.5 lb.	2.5 lb.
Lime	4.5 lb.	3.5 lb.
Sugar	1/2 oz.	1/2 oz.
Water	1 gal.	1 gal.

These compositions are effective for both biological and chemical agents. However, if diatomaceous earth is available following composition is preferable for biological contamination.

Slurry for Biological Decontamination

Water	10 gallons
Diatomaceous earth	16 lb.
HTH	2.5 lb.
Household detergent(All, Vel, Fab, etc.)	7 oz.

Compared to the HTH-lime slurries, it is less corrosive, clings to surfaces better but rinses off more readily, and is economical in the use of HTH. Diatomaceous earth (trade names Diatomite, Celite, etc.) is used as a filter aid by most swimming pools and some water works, and industrial plants.

Dry Mix. A dry mix consisting of one part HTH by volume (one shovelful) to three parts (three shovelfuls) of dry earth, sand, or ashes is sometimes used in chemical decontamination. Decontamination of roads and paths is one application. Decontamination workers may shuffle their boots in dry mix before beginning decontamination in operations in which their boots are likely to be exposed to blister

agents on the ground. Dry mix may be placed under metal equipment to decontaminate any agent flushed from it.

Precautions. HTH is highly corrosive and care must be taken in its storage and use. It should be immediately washed from the skin. If eyes are involved, they should be washed with copious amounts of warm water. It is also injurious to most fabrics.

Sources of Supply.

HTH	Wholesale chemical distributors Sanitary and janitor supply firms Farm and dairy supply stores Swimming pool supply firms Waterworks (occasionally)
Hydrated(slaked) lime	Farm and garden supply stores Building supply firms Hardware stores
Diatomaceous Earth	Swimming pool suppliers Waterworks (occasionally) Industrial plants using filtration processes, e.g., chemical manufacturers, breweries, sugar refineries, vegetable oil processors.

Sodium Hypochlorite (household bleach)

In solid form, sodium hypochlorite (NaOCl) is an unstable substance with a disagreeably sweet odor. In water solution, it is known commercially as household bleach and is more stable than in the solid form. Commercial solutions vary in strength but usually contain up to 5.25 percent sodium hypochlorite (5 percent available chlorine) before being opened. Grocery and drug stores stock bleach of this strength for household use under such names as Clorox, Purex, Coop Bleach, etc. For some industrial uses, such as in commercial laundries, bleach is manufactured in strengths up to 14 percent.

Bleach solution constitutes one of the most generally available and useful decontaminating materials, particularly for home use.

Use. Commercial brands of household bleach are excellent biological decontaminants. Solutions can be applied full strength for the decontamination of small areas of terrain and small amounts of equipment. It is diluted (2/3 cup bleach in one gallon of water) for decontamination of cotton clothing and utensils. The clothing should be immersed for three minutes and then thoroughly rinsed in clear water to prevent deterioration. This dilution is also used for decontaminating food packages and some foods and for disinfecting surfaces in building interiors.

When applied against chemical contamination, sodium hypochlorite liberates chlorine, and upon contact with blister agents and V-agents changes them to less toxic chemicals. For surfaces, household bleach is used full strength. If available, the stronger industrial solutions are preferable. The household strength solution is effective in decontamination of V-agents on the skin. It may be applied conveniently with swabs.

Sources of Supply.

Retail and wholesale groceries
Wholesale chemical distributors
Sanitary and janitor supply firms
Dairy and farm supply stores
Swimming pool supply firms
Commercial laundries (occasionally)

Note: Bleach solution is manufactured for local use by many small firms. These may usually be found under "Bleaching Compounds" in the telephone directory "Yellow Pages."

Caustic Soda (Lye)

The chemical name for caustic soda is sodium hydroxide (NaOH). It is a white solid which dissolves easily in water. A water solution is effective

against biological agents and most chemical agents. Caustic soda hastens the hydrolysis of certain chemical agents and destroys others on contact. It is especially effective in decontaminating the G-agents. However, mustard is destroyed only when kept in prolonged contact with hot caustic solution.

Preparation and use. Water solutions of caustic soda are effective in most concentrations, but normally the more concentrated the solution the faster the decontamination. Likewise, hot solutions decontaminate faster than cold solutions. A 5 percent solution, prepared by dissolving 5 pounds of caustic soda in 12 gallons of water, is recommended for most decontamination operations.

Considerable heat is generated when solutions of caustic soda are prepared, and the containers must not be handled with the bare hands. Iron or steel containers are suitable; glass or earthenware containers can be used if the solid caustic is added slowly to the water and the solution is stirred constantly to keep the temperature down. Solutions should not be prepared in aluminum, tin, or zinc containers.

An excellent method for simultaneous mixing and applying is to sprinkle dry caustic soda on the contaminated area and then dissolve the caustic with a spray of steam or hot water. Care must be taken to see that the steam or water does not wash the caustic soda off the contaminated surface until the decontamination is adequate.

Precautions. Caustic soda, in both solid and solution form, is corrosive to skin, eyes, and clothing on contact. It causes burns to tissue, and eats away clothing. Both woolen and cotton clothing are greatly deteriorated by even a 5 percent solution. Personnel handling caustic solutions should wear rubber gloves.

Prolonged contact with even dilute solutions has a destructive effect on tissue. Ingestion causes damage to the mucous membranes. Inhalation of the dust or concentrated mist can cause upper respiratory or lung damage

varying from mild irritation to a severe pneumonitis. Spills on skin should be immediately washed off with plenty of water, then with vinegar or dilute acetic acid to neutralize any remaining caustic. Clothing should be removed at once and both clothing and affected skin areas washed with water. If eyes are involved, they should be flushed at once with warm water and then given medical attention.

Sources of Supply

Wholesale chemical distributors
Wholesale and retail groceries (as lye or "Drano")
Janitor supply firms
Industrial plants using caustic in processes

Washing Soda

Common names for washing soda include soda ash, sal soda, and laundry soda; the chemical name is sodium carbonate. It is a white powder having alkaline properties. Commercial grades may contain large amounts of sodium bicarbonate (baking soda).

Action. Washing soda solution, hot or cold, is effective for decontaminating G-agents by hastening their hydrolysis. It does not kill biological agents and does not destroy blister agents as readily as caustic soda solution or sodium hypochlorite solution. In addition, it does not destroy V-agents as readily as sodium hypochlorite solution.

Preparation and Use. A 5 percent washing soda solution is prepared by adding 5 pounds of washing soda to about 12 gallons of very hot water and stirring rapidly. The solution should be applied to the contaminated surface hot. A 10 percent solution is used for spraying operations.

Precautions. Washing soda adversely affects the skin, eyes, or clothing. Mists of concentrated solution or powder, if inhaled, are intensely irritating to the upper respiratory tract and mucous membranes and can cause ulceration of nasal passages. If washing soda solution or powder gets into the eyes they should be flushed with copious quantities of water, followed

by prolonged rinsing with dilute boric acid solution. Any washing soda on the skin should immediately be flushed off with large quantities of water. Clothing should be removed and affected skin areas and clothing washed with plenty of water.

Advantages and Disadvantages. Washing soda is relatively inexpensive and available. While it may be easily and safely applied, it is a rather slow-acting decontaminant.

Sources of Supply.

Wholesale chemical distributors

Wholesale and retail groceries

Commercial laundries

Industrial plants. (These frequently stock soda ash as a raw material or for use in chemical processes.)

Protective Ointment CD V-820

This decontaminant is an ointment base containing an organic compound which liberates sufficient chlorine to neutralize blister agents and V-agents. It is not effective against G-agents or biological agents.

The principal uses of the ointment are as a protective measure for skin surfaces before exposure to blister or V-agents and as an emergency skin decontamination measure (page 35). It can also be used for decontaminating small areas of nonporous or slightly porous surfaces but is ineffective for highly porous surfaces.

Protective ointment is distributed through civil defense supply channels.

Soaps and Detergents

Soaps and detergents are readily available and have considerable value as decontaminants, although they are not as effective as the stronger chemicals discussed above.

Action. In biological decontamination they aid the washing process in removing organisms and have a significant germicidal effect. Soap and water is the only decontaminant used to remove biological agents from personnel. By lowering the surface tension of water they assist in emulsifying and removing liquid chemical agents, as well as neutralizing acidic agents (e.g., G-agents).

Organic Solvents

Action. Common organic liquids such as gasoline, kerosene, naphtha, alcohol, and perchlorethylene may be used as solvents for chemical agents. They decontaminate by flushing the chemical agents from the contaminated surfaces. Their value in biological decontamination lies in removing greasy or oily films which might hold the biological agents. In addition, alcohols, including rubbing alcohol, have some germicidal effect and are applicable as an expedient in decontamination of the skin.

Use. Solvents have limited application in biological decontamination. Their use should be confined to removing greasy or oily films, and they are used only in the absence of more effective (germicidal) methods. In chemical decontamination solvents must be used carefully to avoid spreading the contamination. Swabs saturated with solvent are applied to small areas. A contaminated area is swabbed several times, with swabs changed as necessary. The number of times an area is swabbed is determined by the amount of contamination, how greasy the surface, and whether the area will be treated with another decontaminant such as slurry or household bleach.

Solvent extraction is the principal method for removing chemical contamination from woolen fabrics. The dry cleaning process (p. 84) is an example.

Precautions. After being used on a surface contaminated with chemical agents, the cloth end of the swab must not be touched to the bare

skin or clothing. The solvent used to wash off chemical agents becomes contaminated and must be discarded and the swabs must be buried with a covering of dry mix or burned. If ground contaminated with waste solvent is to be occupied it must be decontaminated. Safety precautions against fire hazards should also be observed by personnel handling gasoline, kerosene, or alcohol.

Sources of Supply

Perchlorethylene

Wholesale chemical distributors

Dry cleaners

Cleaners' supply firms

Industrial plants using degreasing operations on metal products

Petroleum Products

Filling stations

Petroleum distributors

Cleaners' supply firms

Alcohols

Wholesale chemical distributors

Wholesale and retail drug firms

Filling stations (methyl alcohol as "non-permanent" antifreeze)

Degreasing Solvent.

Self-emulsifying degreasing solvent (known as GUNK) is a noncorrosive, water-dispersible liquid commonly used to clean aircraft and automotive engines by absorbing grease and oily dirt. As such, it may be used in decontamination operations, and is effective in removing chemical agents by solvent aotion through removal of grease or oil holding the agent. Efficiency in removing biological agentsis estimated at 85-95%.

Use. Gunk is used as a 10% solution in water or a 20% solution in kerosene. After being applied to contaminated equipment, the solvent is allowed to remain 15 minutes or more, depending on the condition of the equipment and the degree of contamination. Water, preferably under pressure, is used to remove the solvent and to flush dirt, grease, oil, and contamination from the equipment.

Source of Supply.

Automotive supply firms.

Vapor or Gaseous Decontaminants

The decontaminants discussed below are characterized by their application in vapor form and are intended for biological decontamination only. Because of their nature they are used for interior spaces or in enclosed containers. They are suitable for biological decontamination of spaces or articles which could not stand the more drastic liquid chemical decontaminants.

Formaldehyde is the vapor decontaminant most likely to be generally available. However, other decontaminants which have particular useful properties are described and conditions for use given in the event that they can be obtained.

Formaldehyde Solution, USP

Formaldehyde (sometimes called formalin) is normally stocked as a 37 percent solution of gaseous formaldehyde in water. Some compositions contain a few percent of methanol as a stabilizer in storage, but, as will be seen, this is an advantage rather than a disadvantage.

Effects. Formaldehyde is toxic to man in the concentrations required to sterilize enclosed spaces and is extremely irritating in lower concentrations. Vapors of formaldehyde tend to polymerize to paraformaldehyde and deposit a white powder on horizontal surfaces. The persistency of this

residue increases the length of aeration which is necessary before the space can be reentered. It will discolor papers seriously but is relatively non-corrosive. It can generally be assumed that any equipment or apparatus that will not be damaged by the necessary humidity will not be damaged by the formaldehyde.

Use. Formaldehyde can be disseminated as an aerosol from a variety of dissemination devices. Insecticide sprayers, as used by pest control operators, are the type generally used for rooms or for small buildings. Those which utilize steam as a propellant are preferable. For larger spaces such as warehouses the fog-type insecticide sprayers, used by mosquito control teams, are suitable. Tight sealing of spaces is not necessary, but large cracks should be covered with masking tape and air conditioners and ventilating systems should be shut off. Cabinets, drawers, and inside doors snould be opened. The use of fans to distribute the fapors within the enclosure is recommended.

A full strength solution is sprayed in the amount of 1 quart per 1,000 cubic feet of space. The best temperature for use is between 70° to 80° F, with a relative humidity of 70 percent or more. Minimum effective temperature for formaldehyde is 60° F. The temperature of the enclosure can be raised through the use of radiators and stoves within the area to be decontaminated. An increase in humidity can be achieved by disseminating water from the sprayers before starting the decontamination operation.

Vapors should be allowed to remain sixteen hours in the closed structure. Aeration, even with forced ventilation, should continue at least twenty-four hours after decontamination with formaldehyde. Polymerized formaldehyde (white powder) on horizontal surfaces may be removed by washing with hot water.

Better results are obtained if the formaldehyde is mixed with methanol in the ratio of 5 parts of formaldehyde to 3 parts methanol (nonpermanent antifreeze). This mixture decreases the amount of formaldehyde residue

and the aeration time required before one can safely reenter the building being decontaminated. Eight-tenths quart of the formaldehyde-methanol solution should be used per 1,000 cubic feet of space involved.

Decontamination of equipment can be carried out in a pit dug by a bulldozer and a gas-proof tarpaulin pulled over the top, or without the pit but with the tarpaulin over the equipment. The tarpaulin should be made of butyl-coated nylon or a similar gas-proof material. Dirt is shoveled onto the edge of the tarpaulin around the entire periphery to assure that the decontaminant does not leak from the improvised chamber before sterilization is completed. The temperature, relative humidity, concentration conditions, and exposure times mentioned above also apply to the use of formaldehyde in this situation.

In the absence of disseminating equipment, formaldehyde can also be vaporized in small closed areas (and the humidity raised) by adding calcium hypochlorite pellets (70 percent available chlorine) or technical grade potassium permanganate to the solution in a pan or bucket. These chemicals can usually be obtained from chemical distributors. For each 1,000 cubic feet of space add 20 oz. of potassium permanganate or calcium hypochlorite pellets to one quart of formaldehyde solution.

Precautions. Workers handling formaldehyde should wear protective masks, rubber gloves, and the best protective clothing available, preferably of the impermeable type. Once vaporization has started, the space should not be entered, even with masks, until the decontamination period is over and the space is at least partially aerated.

Sources of Supply.

Wholesale chemical distributors
Wholesale drug firms
Retail drug stores (occasionally)
Industrial plants manufacturing plastics
Medical schools and hospitals

Practically all embalming fluids contain formaldehyde in the range of 25 to 35 percent, plus other ingredients. Some compositions closely approach the preferred formaldehyde-methanol mixture. Funeral parlors and funeral supply houses thus present a potential emergency source. If the composition is unknown it is safest to assume a formaldehyde concentration of 25 percent and adjust the quantities vaporized accordingly.

Ethylene Oxide and Its Mixtures

Ethylene oxide is a toxic, highly penetrating vapor which is an effective biological decontaminant. When the pure vapor is mixed with air it is flammable or explosive. Therefore, it is not recommended for civil defense use in decontamination of building interiors.

For decontamination or sterilization purposes ethylene oxide is sold in mixtures with non-flammable gases. Typical compositions are 10% ethylene oxide -- 90% carbon dioxide (trade name "Carboxide") and 11% ethylene oxide -- 89% halogenated hydrocarbons (various trade names, "Cry-Oxcide" for one).

Advantages and Disadvantages. The advantages of ethylene oxide mixtures as decontaminants in comparison to formaldehyde include: penetrating power; noncorrosiveness; effectiveness at normal relative humidities, and nonpersistence (except in rubber, plastics, and leather). As disadvantages: they must be used in essentially gas-tight enclosures; relatively large quantities are required; and stocks are not widely distributed throughout the country.

Use. Because of their high penetrating power, ethylene oxide mixtures must be used with gas-tight enclosures

When quantities of material are to be decontaminated, fumigation chambers as found in many storage warehouses, pest control operators'

establishments, and food processing companies (especially coffee and spices) are suitable. The mixtures are used at the rate of 120 lb. per 1,000 cubic feet of space. Contact time should be 6 to 8 hours at 70° F or higher and 12 hours at 60° F. Use of ethylene oxide below 60° F is not recommended. Relative humidities in the range of 20 to 40% are satisfactory.

Clothing and small items of equipment may be sterilized in a plastic drum liner (about 6 feet by 2-1/2 feet when laid flat) made of four-to-six mil polyethylene film.

The items to be sterilized are placed in the bag with a towel or rag and a 16-ounce can of ethylene oxide/halogenated hydrocarbon mixture. The can should be fitted with a needle valve with a can holder and hollow needle to release the mixture. A closure is made by twisting approximately two feet of the open end of the bag, folding it over on itself, and tying it tightly with a piece of string. The can is grasped from the exterior of the bag and the valve is opened while holding the can in an inverted position. The liquid, as it emerges from the can, is directed into the towel or rag, since liquid ethylene oxide and halogenated hydrocarbons are strong organic solvents.

A 55-gallon drum can also be used as the container in which to sterilize items with ethylene oxide mixtures. The drum must have a tight-fitting ring closure to prevent leakage of ethylene oxide. The drum should be modified by cutting a 1/2-inch hole in the lid., and brazing a 1/4- to 3/8-inch pipe reducer to the hole. A needle valve, with can holder and an inductor tube, is attached. To operate, items to be sterilized are placed in the drum, the lid is attached securely, a can of ethylene oxide/halogenated hydrocarbon mixture is screwed down on the hollow needle, and the mixture admitted to the system by opening the needle valve. The drum is then left 8 to 12 hours in an upright position.

Precautions. Protective masks should be worn when working with ethylene oxide mixtures indoors. Using the expedient methods discussed above outdoors does not require masking.

After decontaminating articles of clothing they should be thoroughly aerated -- up to 18 hours if they are to be worn next to the skin. Plastic, rubber, and leather articles absorb ethylene oxide, and if they are to be worn should be aerated overnight.

Sources of Supply.

Hospital and medical supply firms

District warehouses of a few chemical manufacturers

Methyl Bromide

Methyl bromide, used by some pest control operators for insect fumigation, is also effective as a biological decontaminant under proper conditions. It is especially suitable for leather and woolen items. However, the amounts required and the limited availability throughout the country militate against its use.

Use. The plastic bag and 55-gallon drum procedures described above for ethylene oxide mixtures can be adapted for use with methyl bromide. The quantity to be used in either case is 7 ounces. Contact time should be at least 12 hours and it should not be used below 70° F. After decontamination, articles must be aerated for at least 2 hours.

Methyl bromide is highly toxic and will blister the skin. Protective masks should be worn while handling the material, and even then decontamination should not be attempted in closed spaces.

Sources of Supply.

Pest Control operators

Chemical distributors (occasionally)

CHAPTER V

SPECIFIC APPLICATIONS

This concluding chapter identifies the methods and decontaminants recommended for use in the varying situations which may be faced in decontamination operations. In this respect it summarizes and applies the understanding and knowledge gained from the preceding chapters.

Food

Food stored in containers that are resistant to the passage of biological agents requires only that proper exterior decontamination be performed and that precautions in opening the containers be exercised to insure that the contents are not recontaminated. Containers made of metal, glass, plastic, or porcelain can be immersed for five minutes in hypochlorite solution containing about 0.2% available chlorine. Addition of two-thirds of a cup of household bleach (page 58) or 1/2 ounce of 70% calcium hypochlorite (page 55) to one gallon of water gives this concentration. As an expedient method, contamination may be reduced to a safe level by soaking the containers for a minimum of fifteen minutes in boiling soapy water, followed by rinsing. The hands must be free of contamination during opening operations.

Food packages which will not stand immersion should be wiped off with hypochlorite solution and the food cooked before eating.

The exterior surfaces of stocks of food packed in impermeable packages can be sterilized by vapor disinfectants such as formaldehyde (page 65), ethylene oxide mixtures (page 67), or methyl bromide (page 69),. Refrigerated food-transport vans can be used as sterilization chambers. Semi-trailer vans are satisfactory chambers in which to sterilize packaged food with formaldehyde vapors, but ethylene oxide and methyl bromide are too penetrating to be used in the ordinary semi-trailer van.

Foods stored in sacks or other permeable containers also can be decontaminated with methyl bromide or ethylene oxide, but because of the limited availability of these materials it is probable that reliance must be placed on cooking before consumption (see below).

Foods that can be peeled or pared may be decontaminated by soaking in 0.2% hypochlorite solution as above. After decontamination the food is then peeled or pared, washed with potable water, and, if appropriate, cooked before eating. This method has been applied satisfactorily to apples, potatoes, and eggs in crates.

Heat is the most practical means of decontaminating food contaminated with biological agents. Thorough cooking will reduce contamination to a safe level so that food can be consumed. Food items may be decontaminated by one of the following heat methods:

a) Cooking in a pressure-type cooker (autoclave) at 15 lb. pressure at 250° F. for fifteen minutes.

b) Baking some contaminated items such as bread or related items (in a preparatory stage) for 40 minutes at 400° F.; baking meat at 325° F. for about two hours.

c) Boiling certain items for at least fifteen minutes as an expedient method when no other method is available.

Foods that will not withstand any of the above treatments, such as butter and ice cream, must be destroyed.

An important consideration is care in handling and maintenance of high sanitary standards in preparing and serving food after decontamination. Utensils should be decontaminated by boiling at least fifteen minutes or by scrubbing with hot soapy water and rinsing with hypochlorite solution. Hands of food-handlers should be washed frequently and occasionally dipped in the hypochlorite solution.

Foods contaminated with chemical agents present more difficult problems. In certain instances food and food packages contaminated with these agents may be decontaminated and reclaimed for use. Heavily contaminated items should be handled by personnel trained in decontamination procedures and equipped with masks and appropriate protective clothing.

Thus, any decontamination attempted in the home must be confined to food items exposed only to vapors (the most probable exposure under home conditions). Sealed containers may be aerated (Group I, below), washed with 5% washing soda solution, or washed with hot soapy water. Where applicable, items poorly protected but exposed only to vapors can be trimmed or peeled, washed in water or 2% sodium bicarbonate (baking soda) solution and boiled for 1/2 hour or more (procedures c, d, and e below).

Contamination with liquid chemical agents would usually be confined to food stocks in the open at the time of attack, e.g., on trucks, loading docks, etc. Decontamination of such stocks as well as supplies exposed to vapors in wholesale and retail groceries should be an organized civil defense operation.

Prior to initiating decontamination operations a careful survey should be made to determine the extent of chemical contamination. The Food Testing and Screening Kit, CD V-903, provides simple and fairly rapid tests for detection of certain chemical agents in food and food packages. It will detect G-agents and blister agents. Directions for its use are contained in each kit, and the set is described in Appendix F. Tests are usually performed by health personnel or specially trained personnel.

Contaminated food items should be divided into the following groups for separate treatment:

Group I - Canned and packaged food items that have been exposed to vapors only. The degree of protection afforded by the various types of wrapping materials will have a direct bearing on the extent of contamination.

Group II - Canned and packaged food items that have been contaminated with liquid agents. Strip off outer wrappings from packaged food until an uncontaminated wrapping is reached, and place such items in Group I. If an uncontaminated wrapper is not reached or if penetration of food has occurred, place in Group III. Warning - attempts to decontaminate packaged materials may spread the contamination.

Group III - Unpackaged or poorly packaged food items that have been exposed to agent vapors or contaminated with liquid agent. It is not practicable to salvage foods heavily contaminated with liquid blister agents or nonvolatile (V) nerve agents. If food supplies in this group must be conserved and contamination is light the decontamination procedures outlined below may be followed. Unprotected foods with high fat contents are difficult to decontaminate and should be destroyed.

Food supplies heavily contaminated with chemical agents should be immediately segregated to minimize spread of the contamination. The procedures applicable to the various groups are as follows:

a) Aeration or weathering. Group I items may be decontaminated by aeration for a short period of time.

b) Chemical decontaminants. Group II canned items may be decontaminated by use of slurry (page 66.), 5% hypochlorite solution (page 125), or 5% washing soda solution.

c) Trimming or peeling. Group III items may have outer surfaces trimmed or peeled to remove contamination. An example of this is the removal of surface fat and heavily

contaminated areas. This action should be followed by step (d).

d) Washing. Group III items that have been trimmed or peeled may be washed in water or in 2% sodium bicarbonate solution followed by step (e). Washing with hot soapy water will remove contaminant from the outside of canned foods. (Group II).

e) Boiling. Following steps (c) and (d) above, group III items should be completely decontaminated by boiling in water for one-half hour or more.

Food in sealed freezers, refrigerated trucks, refrigerated boxcars, tank cars, refrigerated warehouses, home freezers, etc., is safe if these units remain tightly sealed until the outer surfaces are decontaminated.

Water

Water stored in containers that are resistant to the passage of biological or chemical agents will be safe for consumption after decontamination of the container, provided it is not recontaminated during handling. If home or building water supplies are shut off at the time of an attack, the water remaining in the system, including that in the hot water tanks, should be safe for use. After an attack water should not be used from the municipal system until it has been announced as safe by the municipal authorities.

If the municipal water supply is not damaged by an enemy attack, obtaining purified water should not be a major problem following exposure to an aerosol of a biological agent, because the regular (or intensified) water sterilization procedures will provide an adequate treatment. Care must be exercised, however, to avoid contamination in the vessels or containers used in dispensing the water.

Home Water Supplies

If the municipal water supply has been disrupted by enemy activity, urban residents will have to apply their own sterilization measures against biological contamination to whatever water they can get. Adequate measures include boiling or treating with readily available chemicals. Boiling water for fifteen minutes will insure safety, and this procedure is recommended in case of any doubt.

The following materials frequently available in the home can also be used to sterilize water.

Table 4

Emergency Disinfection of Small Quantities of Clear Water

Disinfectant	Amount per Quart	Standing time - Minutes
Household Bleach (5% available chlorine)	2 drops	30
Tincture of Iodine	6 drops	30
Hydrogen peroxide (3%)	2 teaspoonfuls	120
Halozone tablets	4 tablets	30
Globaline tablets	6 tablets	30

In using bleach or tincture of iodine, there should be a distinct residual odor of chlorine or iodine at the end of the standing period. If there is not, repeat the procedure until the odor remains.

Undamaged wells in suburban and rural areas should supply safe water provided care is taken to avoid contamination during dispensing and use.

Home decontamination of water containing chemical agents is not practicable. Reliance must be placed on protected (covered) water supplies, wells, or decontaminated water provided by the civil defense authorities.

Public Water Supplies

From the standpoint of biological decontamination in public water systems, the essential requirement is to maintain free available chlorine residuals of at least 1 part per million after an assured contact period of at least 5 minutes. This will destroy 99.9 to 99.99 percent of the most likely BW agents. It can be attained in standard waterworks practice by increasing the chlorine addition, frequent testing, and assuring the holding period.

This is also recommended as a minimum standard in operation of the Civil Defense Portable Water Purification Unit. Note particularly that the 1 ppm. residual refers to free available chlorine. Also, if the raw water supply is taken from a surface, or otherwise questionable, source, the requirement must be met after the normal coagulation and filtration steps.

After chemical attack the prompt provision of a safe public water supply is especially important since there is no practical home purification procedure. If the public system is operable, the safety of the water can be determined by testing; and decontamination procedures can be instituted if it is found to be contaminated.

The Water Testing and Screening Kit, CD V-902 (Appendix E) will detect G-agents and blister agents. It does not have a capability for V-agents. The latest model CD V-810 kit (Appendix D) can detect V-agents. Although this kit does not have specific instructions for use on water, it could serve as an interim device.

In addition to the detection kits, the following information might be indicative of chemical contamination in the raw water:

a. Dead fish or other aquatic life, including vegetation,
b. Unusual odor to the water, perhaps characteristic of known chemical agents.
c. An unusually high chlorine demand to the water.
d. Intelligence information indicating a general toxic chemical attack, or perhaps direct sabotage of the water system.

Various methods of purification can be used depending upon the particular agent present. However, a general BW/CW water decontamination procedure has been developed, effective regardless of the agent present. In some cases, this method is not the most economical or easiest to perform, but it has the advantage of being universally effective against the potential water-borne contaminants. The procedure is as follows:

General BW/CW Water Decontamination Procedure

1. Superchlorinate with 70% strength calcium hypochlorite to 100 ppm. available chlorine. Allow an average contact time of 40 minutes or more. It is important that 70% calcium hypochlorite be used and not liquid chlorine or some other oxidizing agent. HTH not only elevates the pH but also provides catalytic hypochlorite ion, both essential for the destruction of G-agents.
2. Dechlorinate with 600 ppm. activated carbon.
3. Coagulate and filter water in accordance with standard water purification methods.
4. Post chlorinate to a total residual chlorine concentration of 2 ppm.

The added superchlorination and dechlorination steps can usually be incorporated into waterworks procedures, with some reduction of normal processing capacity. If the BW/CW decontamination procedure is used with the Civil Defense Portable Water Purification Unit, additional tanks and pumps must be provided.

Operators processing contaminated water should wear protective clothing and masks.

Surfaces and Materials

The selection of an agent for biological decontamination of a surface or item is dependent upon the type and size of the contaminated material, the time available in which to accomplish the operation, and the availability of decontaminants. In many instances, biological decontamination is best achieved through isolation of the area or item while natural decontamination occurs.

In chemical decontamination, various types of surfaces and materials require different procedures because of their differences in composition, absorptive and adsorptive powers, and stability on exposure to chemical agents and decontaminants. Decontaminants and methods for decontamination of various surfaces and materials contaminated with toxic chemical agents are tabulated in Appendix A.

Buildings and Building Materials

Biological decontamination of the exteriors of buildings should not be attempted except as a last resort. Natural decontamination by wind, rain, and sunlight will eliminate most organisms within the period of a day. Slurry or, preferably, the biological decontamination slurry can

be used if rapid decontamination is necessary(both, page 56).

Wood is easily penetrated by liquid chemical agents. If possible, it is best to allow weathering to remove contamination from wooden buildings. When wooden objects have been heavily contaminated by liquid chemical agents, decontamination becomes impossible, and the objects should be burned. For lesser contamination, slurry is preferred, since it clings to contaminated surfaces and neutralizes the escaping vapors. Thus it is the most effective decontaminant for wood which requires decontaminating. Slurry is applied by means of power-driven spray apparatus, swabs, or brooms. It is allowed to remain in contact with the contaminated surface for twelve to fourteen hours or longer, the length of time depending upon the degree of contamination. Slurry must be thoroughly applied to cracks and crevices. If periodic tests made with the detector kit indicate the necessity, the surface should be flushed and slurry applied a second time. After decontamination the surfaces are flushed with water. Where wood is an essential part of an item, it can be treated with slurry for partial decontamination. Then it can be washed with hot soapy water for complete decontamination, if necessary.

Brick, Tile, Stone, and Concrete.

Brick and concrete are easily penetrated by liquid chemical agents, and decontamination of the surfaces alone is not sufficient. Slurry is applied and allowed to remain at least 24 hours before flushing. It is reapplied if test results indicate a necessity for further decontamination.

Glazed surfaces do not absorb as much chemical agent as rough materials. Smooth or glazed surfaces on the outside of buildings are flushed with water. The heavy concentration of chemical agent deposited on the ground as a result of flushing is neutralized with HTH or dry mix (page 56)..

Painted and Varnished Surfaces

Most painted and varnished surfaces readily absorb liquid chemical agents. Such contaminated surfaces are treated with slurry, leaving it on for twelve to twenty-four hours before removal. If slurry is not available, hot soapy water is used. When a chemical agent has soaked into paint, the agent cannot be removed completely without removal of the paint.

Metals

Slurry is effective against both biological and chemical agents but severely corrodes most unpainted metal surfaces if allowed to remain in contact for more than one hour or if subsequent cleaning and oiling is not thorough. Hot soapy water is the best choice for both types of agents. Boiling is applicable for small objects.

Other alternatives include vapor decontamination for biological agents, and solvents for removal of chemical agents.

Terrain

Biological decontamination of terrain is not considered feasible except under special circumstances. As with buildings, the area should be evacuated if possible until time and weather remove the contaminant. For small vital areas, slurry or full strength household bleach solution may be used, applied with power-driven or hand-operated spray equipment. The decontaminant must come into direct contact with the organisms in order to kill them. Spreading water or oil on the roads will aid in keeping the organisms on the ground and in reducing the chances of creating secondary aerosols. However, the use of water and oil to suppress aerosols may increase the persistency of the biological agent on the road.

The use of chemical decontaminants on large areas contaminated with chemical agents is not economically feasible. Decontamination by means of fire, weather, and earth-moving equipment such as bulldozers is more practical if large area decontamination is absolutely required. The use of slurry, dry mix, or full-strength sodium hypochlorite solutions may be justified on small, vital areas and limited access routes. Roofing paper, wood mats, or other covering may be used to provide temporary access paths allowing the passage of people . The procedures recommended for various types of roads, runways, and other terrain features are listed in Appendix A.

Interior Spaces

For biological contamination the interiors of buildings which can be sealed can be decontaminated with formaldehyde vapor (page 65) followed by aeration. If vapor decontamination is used, proper conditions must exist or be created (temperature and relative humidity) for the formaldehyde to be most effective. If the materials within the space will not stand this treatment, or if it cannot be vacated for the necessary time for decontamination and aeration, reliance must be placed on washing down all accessible surfaces with household bleach (diluted to 0.2%, page 68), or hot water and soap. Furnishings and other materials in the rooms must be decontaminated by methods appropriate to them.

Chemical agent contamination in interior spaces may be expected to be confined to vapors rather than liquid agents. Thorough ventilation and aeration is the most practical procedure.

Individual Belongings

Fabric Items

Clothing, bedding, and other fabric items which can withstand laundering or boiling can be decontaminated from both chemical and biological agents by these procedures.

For biological contamination, cotton clothing can be decontaminated by boiling for a minimum of 30 minutes. It can also be decontaminated by immersing in a 0.2% household bleach solution (2/3 cup to one gallon water) for thirty minutes, followed by thorough rinsing in clear water to prevent deterioration.

Cotton items contaminated with chemical agents should be boiled for one hour; the addition of soap hastens this process against all agents, particularly G-agents. G-agents may also be removed from cotton fabrics by soaking in a 5% solution of washing soda for two hours at ordinary temperatures, followed by rinsing in clear water.

Ordinary laundering, either home or commercial, will greatly reduce both biological and chemical contamination. Effectiveness is increased by using water as hot as possible and adding bleach in the first sudsing operation. For cottons, water in the range of 140 - 160° F. is desirable, but for woolens the temperature must be held down to 100° F. to avoid excessive shrinkage. It must be recognized that hypochlorite bleach may cause fading of colored fabrics and "tendering" of woolens, the degree depending upon the concentration used.

A concentration of 2000 ppm. (parts per million) available chlorine in the first sudsing operation of a normal laundry procedure will assure complete decontamination, both biological and chemical. It has the further advantage of completely disinfecting the wash water. A home washer with

water capacity of 10 gallons would require 6-2/3 cups of 5% household bleach to yield this 2000 pp. concentration -- adequate to kill highly resistant organisms and neutralize heavy liquid chemical agent contamination. In contrast, normal commercial laundry practice uses 75 - 100 ppm. and the usual recommendation for home washers (1 cup per load) approximates 300 ppm.

Unless the biological contamination has been identified as a highly resistant organism or the chemical contamination is so heavy as to be visible, the following are recommended as reasonable compromises.

- For Home Laundering - twice the quantity recommended by the bleach manufacturer, in the first wash. This would be two cups of household bleach per 10 gallons of water. Water should be as hot as possible, up to 140° F. (100° F. for woolens).

- For Commercial Laundries - normal laundry cycle, but adding 600 ppm. available chlorine in the first suds. Water temperatures normal, 140 - 150° F. (100 degrees F. for woolens).

With extremely heavy contamination or highly resistant organisms, e.g. spore-formers, the chlorine content should be increased to the full 2000 ppm. (0.2%).

Secondary aerosols are readily generated in handling biologically contaminated fabric items; thus respiratory protection is particularly necessary for laundry workers. Care must be exercised to avoid recontamination after washing. Dryer or tumbler rooms should be well ventilated. Sorting tables, baskets -- any dry surfaces that decontaminated items contact -- should be washed down frequently with dilute bleach solution.

Fabric items which are not amenable to laundering procedures, such as mattresses and many woolen items, require vapor-type treatment for

biological contamination. Formaldehyde (page (65) is the most probable, although ethylene oxide mixtures and methyl bromide are excellent if supplies and facilities are available.

Dry cleaning and solvent extraction are suitable methods for chemical decontamination of all fabrics, and especially for woolens. Normal dry cleaning procedures may be used, taking necessary precautions for protection of the workers and safe handling and disposal of contaminated solvent. Extraction with organic solvents (p. 62) is an expedient method. The recommended procedure is: immerse for two minutes in a can filled with solvent; wring out and immerse in clean solvent for two more minutes; wring out and immerse in clean solvent again; then wring out and hang up to aerate for four or five hours. Solvents such as dry cleaning solvent, kerosene, or gasoline may be used. Safety precautions, as in dry cleaning (above), must be observed, as well as normal safety measures for flammable liquids.

Leather and Rubber Articles

Vapor decontaminants are preferred for biological contamination of leather articles and rubber items such as boots, gloves, and impermeable clothing. Thorough aeration is required before they can be worn. As an expedient, dilute household bleach solution (0.2%) may be used.

Since leather and ordinary rubber quickly absorb liquid chemical agents, decontamination should be accomplished as quickly as possible by washing or wiping off the liquid agent, followed by thorough decontamination when the situation permits. If the agents have been allowed to penetrate for a considerable period of time, the articles cannot be made safe for use; they should be buried or burned.

The soaking procedure described below for items heavily contaminated with chemicals is also an alternative for biological decontamination.

Assuming early removal of most of the chemical agent, lightly contaminated articles can be aired in sun and wind for 12 to 24 hours for leather goods; several days for articles made of ordinary rubber. More heavily contaminated items require soaking in hot soapy water (not over 130° F.) for several hours, rinsing in clear water, draining, and hanging up to dry. Soaking times are: leather, 4 hours; rubber boots and protective mask facepieces, 6-8 hours when heavily contaminated, 3 hours when moderately contaminated; rubber aprons and butyl rubber gloves, 2 hours. Neatsfoot oil or leather dressing should be used to soften leather articles after drying.

Protective Masks.

Decontaminating procedures for the various types of protective masks are given in Appendix C.

Miscellaneous Items

Cooking and eating utensils, small tools, and similar metal, glass, and china articles are best decontaminated by boiling; at least 15 minutes in the case of biological contamination; 30 minutes or more in soapy water for liquid chemical contamination.

As an alternative, they may be washed thoroughly in hot soapy water. For biological contamination they are then rinsed in clear water, dipped in 0.2% bleach solution, and carefully rinsed and dried. For chemical contamination, the washing is followed by rinsing in clear water, drying and aerating.

Equipment

Trucks, other motor vehicles, and construction equipment may become contaminated either during a direct biological or chemical attack, or by secondary aerosols created by operating in a dusty, contaminated area.

Outdoor exposure will usually be sufficient in the case of biological contamination. Washing is desirable as an added protection. Vehicles heavily contaminated, by direct impact of a liquid-filled munition, for example, may require vapor decontamination. This might be done in a closed building or under a tarpaulin (page 66). Use of a steam jenny, as found in many garages and industrial plants for steam cleaning, as a part of the washing process is another possibility.

Under chemical attack, vehicles which can be closed or "buttoned up" will usually be free of interior contamination. External contamination is removed with solvents, by steaming, or by thorough scrubbing with soap and water. Slurry, followed by rinsing, should be used on tires.

Electrical equipment - motors, communications equipment, etc. - usually generates sufficient heat to be almost self-decontaminating. Even though high temperatures are not reached, long exposure to temperatures in the 120-160° F. range, coupled with the drying effect, will kill most varieties of micro-organisms. Similarly, the heat, if adequate ventilation is provided, will evaporate the chemical agents.

APPENDIX A

DECONTAMINATION OF SURFACES AND MATERIALS CONTAMINATED WITH TOXIC CHEMICAL AGENTS

(Note: See Ch. V for further information.)

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Asphalt:			
Roads[1]	Flush with water. Spray with slurry from power-driven apparatus.	Cover with dry mix.	Weather. Cover small areas or paths across roads with 4 inches of earth.
Roof	Flush with water. Spray with slurry from power-driven apparatus.	Cover with dry mix.	Weather.
Brick and stone:			
Roads[1]	Spray with slurry from power-driven apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Wash with soapy water, preferably hot.	Cover small areas or paths across roads with 4 inches of earth. Weather.
Buildings	Spray with slurry from power-driven apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Wash with soapy water, preferably hot. Use HTH or dry mix around buildings, where waste water runs.	Weather.

[1] Applicable to small vital areas only.

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Canvas:			
Tarpaulin, tentage covers	Immerse in boiling, soapy water for 1 hour. Use 5% solution of sodium hypochlorite (household bleach) for V-agents. Use 5% solution of washing soda for G-agents.	Immerse in boiling, soapy water for 1 hour. Launder by standard methods. Use slurry.	Aerate (except for V-agents).
Concrete:			
Roads[1], Buildings	Spray with slurry from power-driven apparatus. Spray with slurry with power-driven apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Cover with dry mix. Wash with soapy water, preferably hot. Apply HTH or dry mix on ground surrounding structure where waste water flows.	Weather. Cover small areas or paths across road with 4 inches of earth.
Earth:			
Roads[1], pathways, bomb craters	Spray with slurry from power-driven decontaminating apparatus.	Cover with dry mix.	Weather. Burn. Cover small areas or paths across roads with 4 inches of earth. Scrape layer of contaminated earth to side of road. Aerate.

[1]Applicable to small vital areas only.

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Leather:			
Boots, gloves, and other items	Scrub with hot, soapy water and rinse. Immerse in soapy water at 120° F. for 4 hours and rinse.	Immerse in a 5% solution of sodium hypochlorite for V-agents.	Aerate.
Fabrics (cotton or wool): Coveralls, shirts, trousers, underwear, socks, gloves, overcoats	For Cotton Items: Immerse in boiling water for 1 hour; stir items; add 1 lb. of soap to 10 gal. of water to make water alkaline. Use 5% solution of sodium hypochlorite (bleach) for V-agents. Use 5% solution of washing soda for G-agents. For Woolen Items: Extract with solvent. Immerse in warm (100° F.) soapy water for 1 hour or longer with light agitation; dry items slowly.	Launder by standard methods. Dryclean.	Rub CD-V-820 Protective Ointment on small contaminated areas. Aerate, except for V-agents.
Glass: Windows	Use 5% solution of sodium hypochlorite for V-agents.	Wash with hot, soapy water. Wash with clear water or organic solvent.	Blot off surface. Aerate. Weather.
Lenses	Use 5% solution of sodium hypochlorite for V-agents.	Wash with hot soapy water. Wash with clear water or organic solvent.	Blot off surface. Aerate.
Grass and low vegetation: Fields, open terrain)[1]	Burn. Spray with slurry from power-driven apparatus.	Cover with dry mix.	

[1]Applicable to small, vital areas only.

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Metals (unpainted): Cooking utensils, canned foods	Immerse in boiling, soapy water for 30 minutes and rinse.	Wash in hot, soapy water, rinse, and aerate.	
Machinery	Wash with hot, soapy water. Wash with organic solvent.	Weather. Aerate.	
Metals (painted): Vehicles, equipment	Wash with hot, soapy water and rinse. (Slurry may be used if it is removed from surface after 1 hour and surface oiled.)	Weather. Aerate.	
Plastics (opaque): Insulation, telephones, panel boards	Wash with hot, soapy water and rinse. Wipe with organic solvent and then rinse.	Weather. Aerate.	
Plastics(transparent): Eyepieces	Wash with hot, soapy water. Wipe with organic solvent and aerate.	Aerate.	
Rubber: Aprons, suits, and other similar items	Immerse in hot, soapy water (just below boiling point)for for 1 hour; do not agitate. Rinse with clear water and hang up to dry. For G-agents, use 10% washing soda solution, rinse off and aerate.	Apply hot, soapy water with brushes and rinse. Spray with slurry from power-driven apparatus. After a few minutes, wash off with clear water.	Aerate. Weather.

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Rubber (natural and synthetic):			
Gloves, boots	Immerse in slurry for 4 hours, rinse off and aerate.	Immerse in hot, soapy water for 2 to 8 hours; Do not boil more than 4 times a year.	Apply CD V-820 protective ointment immediately. Aerate.
Mask facepieces and other rubber articles coming in direct contact with the skin	Immerse in hot, soapy water for 6 to 8 hours for heavy contamination and 3 hours for moderate contamination.	Apply CD V-820 protective ointment immediately. (Apply to both sides of mask facepiece.)	
Tires, hose, mats, insulation	Apply thick slurry, allow slurry to remain at least 30 minutes, then flush with clear water. (May be left on tires.)	Immerse in water for 2 to 3 hours; do not boil more than 4 times a year.	Aerate. Weather.
Sand[1](beaches etc.):	Flush with water.	Spread dry mix or slurry over surface.	Weather. Cover paths with roofing paper. Scrape off 2 to 3 inches of contaminated top layer.
Undergrowth and tall grass(meadows etc.):	Burn.	Spray slurry from power-driven apparatus.	Weather.

[1]Applicable to small, vital areas only.

Contaminated surface or object	Preferred decontamination methods	Alternate decontamination methods	Expedient methods
Wood:			
Buildings, vehicle bodies	Apply slurry with power-driven apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours; flush and repeat application; then flush again.	Scrub with hot, soapy water and rinse.	Weather.
Boxes, crates	Apply slurry with power-driven apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours; flush and repeat application, then flush again.	Scrub with hot, soapy water and rinse.	Weather.
Wood (painted surface):			
Buildings, boxes.	Apply slurry with power-driven apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours. then rinse off with water.	Scrub with hot, soapy water and rinse.	Weather.

APPENDIX B

BIOLOGICAL DECONTAMINANTS AND THEIR USE

(Note: See Ch. IV for further information on these decontaminants.)

Decontaminants	Application	Limitations	Remarks
Formaldehyde solution, USP, 5 parts formaldehyde, 3 parts methanol mixture	Applied as vapor by heat from insecticide sprayers or paint-type sprayers, or vaporized by heat or bubbling steam through pan of material. One quart of undiluted formaldehyde solution, or 0.8 quart of formaldehyde-methanol mixture per 1,000 cu. ft. above 70° F. The amount for each 20° F. drop in temperature should be doubled. Contact time 16 hours. Aeration after decontamination 24 hours.	Vapors highly toxic to personnel. Vapors of pure formaldehyde are flammable; open flam · not suited for vaporizing. W .. steam is used, source of steam should be outside area being decontaminated. Decontamination below 40° F. not advisable. Will not effectively penetrate cloth and similar fabrics. May cause damage to delicate instruments. Dampness may curl and ripple paper. Vapor polymerizes and deposits white powder on horizontal surfaces; this powder may be washed off with hot water. Handlers required to wear masks, rubber gloves, and protective clothing	Once vaporization has started, even persons wearing masks should not enter area until process is completed. Care must be exercised to prevent leakage of solution during storage.

Decontaminants	Application	Limitations	Remarks
Ethylene oxide - halogenated hydrocarbon mixtures	Contaminated equipment should be exposed to vapors in airtight enclosure 6-8 hours at 70° F. Twelve hours at 60° F. 120 lb. of mixture per 1,000 cu. ft. of space.	Requires airtight enclosure to be effective. Toxic to personnel if improperly used. Decontamination below 60° F. is not advisable. Liquid will damage plastics or leather.	Protective masks should be worn during indoor use. Vapor highly penetrating but noncorrosive.
Carboxide	Same as ethylene oxide mixture.	Same as ethylene oxide mixture, except there is no liquid form.	Same as ethylene oxide mixture.
Methyl bromide	Items should be exposed to vapors for 12 hours in closed container. Aeration time should be at least 2 hours.	Vapors are highly toxic. Should not be used in closed spaces where odorless vapors could accumulate.	Noncorrosive to metals and nonflammable. Should be used when ethylene oxide mixture is unavailable.
Calcium hypochlorite, HTH	Solution of 1 lb. HTH to 1 gallon of water can be used for horizontal surfaces. For vertical surfaces, use slurry compositions on page 124.	HTH is highly corrosive to metal. Solution cannot be used in power-driven sprayer. Loses chlorine content rapidly. Should not be inhaled or come in contact with skin or eyes. Protective mask should be worn when preparing slurries.	Packaged in 5-lb cans and 100-lb. drums. Contains about 70% available chlorine when packaged.

APPENDIX C

PROTECTIVE MASKS CD V-800, CD V-860, CD V-805

Information on the CD V-800 and CD V-860 masks respectively is contained in the following:

OCDM Reviewing Draft Appendix NP24-4, November 1960
OCDM Draft Appendix NP24-4.1, November 1960

Instructional material on the CD V-805 should be forthcoming as part of the General Tire and Rubber Company production study contract. Fitting and donning instructions can be identical with those for the other masks, except that testing for leaks by the normal procedure is not possible. Decontamination must be confined to surface treatment, avoiding melting the filter pads, or, in the case of biological contamination - vapor disinfection.

APPENDIX D

CHEMICAL AGENT DETECTOR KIT CD V-810

The Chemical Agent Detector Kit, CD V-810, (Military designation, M15) is described in Civil Defense Technical Bulletin TB-11-29, April 1957. Detailed instructions are given in the bulletin and included in each kit. A refill, replacing all expendable items, is designated CD V-810-1.

The kit will detect and identify the presence of G-agents and mustards in air.

A new model (Military designation, M15A1) adds a V-agent capability. Description and operating instructions are included in Department of Army Technical Memorandum TM 3-6665-211-2, 12 February 1962.

APPENDIX E

WATER TESTING AND SCREENING KIT CD V-902

The Water Testing and Screening Kit, CD V-902, is designed for simple and rapid field tests to detect dangerous chemical contamination in untreated water. It will detect G-agents, mustards, cyanogen chlorides, and arsenicals. V-agents are not detected.

Sufficient quantities of reagents are included to perform 15 complete tests. The unit is expendable; refills are not provided.

Operating instructions and a complete description of the kit are included in Department of the Army Technical Bulletin TB-CML-40, 9 July 1962. Operating instructions are also packed with the kit.

APPENDIX F

FOOD TESTING AND SCREENING KIT CD V-903

The Food Testing and Screening Kit, CD V-903, is a lightweight portable kit designed for simple and rapid field tests to detect contamination of food or food packages by chemical agents. It will detect G-agents, mustards, cyanogen chloride, and arsenicals. V-agents are not detected.

There are no replacement items for the CD V-903 kit. When the reagents or other test materials have been used, or have been contaminated or have spoiled, a new kit must be obtained.

Operating instructions and a complete description of the kit are included in Department of the Army Technical Bulletin TB-CML-41, 1 February 1955, with Change 1, December 1960.

APPENDIX G

FIRST AID FOR CHEMICAL CASUALTIES

OCDM Proposed Appendix NP 24-2.2 provides first-aid information on blister agents and nerve agents. Although not so specified, the material on nerve agents applies to G-agents.

The following points should be noted in connection with non-volatile (V) agents.

a. Protective Ointment, CD V-820, is effective against V-agents, but not against G-agents.

b. V-agents on the skin can be effectively destroyed by 5% sodium hypochlorite solution (full-strength household bleach). Plain water will also remove V-agents from the skin, but is less effective than bleach solution or protective ointment.

c. Prompt treatment of casualties is required. Symptoms and treatment of V-agent poisoning are similar to those for other nerve agents.

APPENDIX H

GLOSSARY OF TERMS

This appendix defines terms as used in this manual, and others which may be encountered in biological and chemical defense literature.

AEROSOL--A cloud of fine particles (liquid or solid) suspended in the air. The particles are so small, less than 10 microns in diameter, that they remain suspended for considerable periods of time instead of settling out. Fog and smoke are aerosols. Chemical and biological agents and radioactive materials can be dispersed as aerosols.

ANTIBIOTICS--Substances produced by and obtained from living cells, usually those of lower plants, such as bacteria and molds; they are antagonistic to other forms of life, including pathogenic organisms. Examples are penicillin and streptomycin. Some may also be produced synthetically.

ANTIBODY--A specific substance produced by the body in reaction to a specific foreign body (antigen), such as bacteria and toxins. Antitoxins are an example.

ANTIGEN--Any substance which when introduced in the body stimulates the formation of an antibody. Antigens are usually protein in nature and react in antagonistic manner with specific antibodies.

ANTISEPTIC--A substance which will inhibit the growth and development of micro-organisms without necessarily destroying them.

ANTITOXIN--A substance found in the blood serum or other body fluids which is specifically antagonistic to a toxin.

ATROPINE--A white, crystalline alkaloid drug extracted from belladonna. Used hypodermically for treatment of nerve gas casualties.

ATTACK--Any act or series of acts by an enemy of the United States causing substantial damage or injury to property or persons in the United States in any manner; by sabotage or by the use of bombs, shellfire, or atomic, radiological, chemical, or biological means or other weapons or processes.

BACTERIA--One-celled micro-organisms which have no chlorophyll and multiply by dividing.

BIOLOGICS--Pharmaceutical products of animal origin, capable of conferring an immunity by virtue of contained antibodies. A general term used to include vaccines, antiserums, toxoids, etc.

BLISTER GASES--Gases used for casualty effect; they injure the eyes and lungs and blister the skin. Formerly called VESICANTS.

BROAD SPECTRUM ANTIBIOTICS--Antibiotics which are effective against a number of infectious agents, rather than specific to a few.

CARRIER--An individual who harbors specific disease organisms without showing symptoms, thus serving as a means of conveying infection. Also particles transporting chemical or biological contamination. See SECONDARY AEROSOLS.

CASUALTY--A person sick or injured and needing treatment, or one killed.

CHEMICAL WARFARE DEFENSE--Steps taken to prevent or minimize the effect of chemical warfare attacks. These measures would include warning, detection, identification of agents, physical protection, decontamination, first aid, and treatment of casualties.

CHEMOPROPHYLAXIS--Use of chemicals after exposure to a disease to prevent or minimize symptoms.

CHLORINE--A heavy, greenish-yellow gas, used in the first gas attack by the Germans in World War I. Its toxicity is low in comparison with modern war gases.

CLOUD--A body of air containing a collection of small particles (liquid or solid) in suspension, usually visible. As used in this manual, includes aerosols, which may be invisible, and bodies of air carrying chemical agents in gaseous form (invisible), e.g. aerosol clouds, gas clouds.

COLLECTI VE PROTECTORS--Filtering devices for purifying all air entering an enclosed space. These include a filter for removing particles and beds of activated charcoal for removing gases. They may be fitted with self-contained blowers or incorporated in the ventilating system of the facility.

COMMUNICABLE DISEASE--An illness due to a specific infectious agent or its toxic products arising through transmission of that agent or its products from reservoir to susceptible host, either directly as from an infected person or animal, or indirectly through the agency of an intermediate plant or animal host, a vector, or the inanimate environment.

CONTACT--A contact is any person or animal known to have been in such association with an infected person or animal as to have had the opportunity of acquiring the infection.

CONTAGIOUS DISEASE--An infectious disease capable of being transmitted from one individual to another. Many infectious diseases are not contagious but require some special method of transmission or inoculation.

CONTAMINATION--The presence of toxic chemical agents, biological agents, or radioactive materials in dangerous amounts on a person, an object, or an area.

COVERT--Hidden, concealed. Covert attack refers to the stealthy employment either of accepted methods or of unusual or sabotage methods which might be used before or after the actual outbreak of hostilities.

CUTANEOUS--Pertaining to the skin.

DEBILITATING--Weakening or lessening of strength.

DECAY--(OR BIOLOGICAL DECAY)--The rate at which infectious organisms become noninfectious or die under unfavorable conditions of light, temperature, or humidity. The decay rate is a major factor influencing stability and persistence of biological agents.

DECONTAMINATION--The process of reducing the personnel hazard associated with an object or area by absorbing, destroying, neutralizing, making harmless, or removing chemical, biological, or radiological agents clinging to or around it.

DETECTION-The determination that biological or toxic chemical agents are present in the air, on surfaces, or in water or other materials.

DISEASE--Illness or sickness.

DISINFECTION--Killing of infectious agents outside the body by chemical or physical means directly applied.

DISPERSE--To break up into particles (including droplets) as a part of the process of distributing biological or chemical agents over or on a target. Also refers to vaporization of chemical agents.

DISSEMINATION--Distribution or spreading.

DISSIPATE--Referring to a biological or chemical cloud--to diffuse and become diluted with air to the extent that it becomes ineffective.

DROPLET INFECTION--Infection by droplets of contaminated respiratory or oral discharges dispersed in the air by sneezing and coughing.

DRUG SUSCEPTIBILITY--A micro-organism's degree of sensitivity or lack of resistance to a given drug.

ENCEPHALITIS--Inflammation of the brain.

ENCEPHALOMYELITIS--Inflammation of the brain and spinal cord.

ENDEMIC--Presence of a disease in a district or area, denoting prevalence more or less continuously; used with human diseases.

ENZOOTIC--Same as ENDEMIC except applicable to animal diseases.

EPIDEMIC--The occurrence in a community or region of a group of illnesses of a similar nature, clearly in excess of normal expectancy,and derived from a common or from a propagated source.

EPIDEMIC SPREAD--Rapid and wide spread of a disease from individual to individual in a given community.

EPIDEMIOLOGY--The study of disease outbreaks in an attempt to identify the source, determine their extent, and the probable mode of transmission and control measures.

EPIZOOTIC--Same as EPIDEMIC except applicable to animal diseases.

EXUDATE--Any substance discharged through pores, lesions, or incisions of tissues; any substance which becomes deposited in or on the tissues by a vital process or a disease.

FEVER--Abnormally high body temperature; characterized by marked increase of temperature, acceleration of the pulse, increased tissue destruction, restlessness, and delirium.

FORMALDEHYDE--An effective disinfectant (decontaminant for biological agents). Properly the term applies to the pure compound in gaseous form. As generally used, refers to a 37 percent solution of gaseous formaldehyde in water, which is also called FORMALIN.

FUMIGATION--Exposure to fumes of a chemical which destroys micro-organisms. Also, a process by which the killing of animal forms, especially insects and rodents, is accomplished by the employment of gaseous agents.

FUNGI--A group of plants ranging down to the microscopic in size. They do not contain chlorophyll, and reproduce mainly by sporulation. Example--molds, mildews, rusts, mushrooms.

GERM--Any micro-organism, especially pathogenic. A microbe.

GERMICIDE--Any agent that destroys germs or micro-organisms, especially disease germs.

HEALTH SERVICES (EMERGENCY)--Medical and dental care for the civilian population in all their specialties and adjunct therapeutic fields; and the planning, provision, and operation of first aid stations, hospitals, and clinics; preventive health services, including detection, identification, and control of communicable diseases, their vectors, and other public health hazards; inspection and control of purity of food, drugs, and biologicals; food and milk sanitation; public water supplies; sewage and other waste disposal; registration and disposal of the dead; prevention and alleviation of water pollution; vital statistics services; preventive and curative care related to human exposure to radiological, chemical and biological warefare agents; and rehabilitation and related services for disabled survivors.

HOST--A man or other living animal, including birds and insects, affording under natural conditions subsistence or lodgement to an infectious agent.

HYDROLYSIS--The reaction of a chemical substance with water to form a new substance. Sometimes the new substance is poisonous, and care must be taken to prevent injury from the hydrolysis product.

IDENTIFICATION--Identifying a particular biological or chemical present when it has been detected. In many cases the detection process also provides identification.

IMMUNITY--Ability of living individuals to resist or overcome infections.

IMMUNIZATION, ACTIVE--Developing immunity by the production of antibodies by the individual's own cells under the stimulus of antigen present as a result of a disease, or which has been introduced into the body artificially.

IMMUNIZATION, PASSIVE--Developing temporary immunity to a disease by introduction into the body of antibodies produced in another person or animal.

INCAPACITATING--Rendering an individual unable to perform his usual duties or functions; as distinguished from lethal.

INCUBATION PERIOD--The time interval between the introduction into the body of an infectious agent and the appearance of the first symptoms of disease.

INFECTION--Invasion of body tissues by organisms, usually pathogenic, which multiply and cause disease; the presence of parasites within the body which cause injury.

INFECTION, ACUTE--An infection with a short, severe course.

INFECTION, CHRONIC--An infection continuing for a long period.

INFECTIOUS AGENT--A micro-organism capable of producing infection, and under favorable circumstances of host and environment, having the capacity to produce infectious disease.

INFECTIOUS DISEASE--One which is caused by a living agent, such as bacteria, viruses, or fungi; may or may not be contagious.

INFECTIVITY--The quality of being infectious or the capacity of an organism to invade and establish itself as a parasite in the tissues of a host.

INFESTATION--Invasion by animal parasites, e.g. lice, fleas, usually on the body surfaces of the host, without necessarily causing injury.

INGESTION--Act of taking food or medicine into the body for digestion, as into the stomach.

INOCULATE--To introduce a micro-organism, vaccine, immunizing serum, or other antigenic substance for preventive, curative, or experimental purposes.

INSECTICIDE --An agent or material that kills insects.

INSECTS--Small invertebrate animals, having six or eight legs; syn. arthropods.

LD_{50}--The dose of organisms or substances which will cause death of 50% of the recipients in a specified time.

LETHAL--Deadly; fatal.

MEDIUM (Plural MEDIA)--Refers to culture medium or variety of materials and their combinations used for growing micro-organisms. It may be solid or liquid.

MICROBE--Any individual micro-organism.

MICRON--A unit of linear measure of the size of particles. One micron is equal to 1/1000 of a millimeter, or approximately 1/25,000 of an inch.

MICRO-ORGANISM--A minute living organism, usually microscopic in size.

MORBIDITY--The state of being diseased. The sick rate, or the ratio of sick persons to the total population.

MORTALITY RATE--The ratio of the number of deaths from a given disease to the total number of cases of that disease. Also FATALITY rate.

MUCOUS--Pertaining to or resembling mucus; also secreting mucus.

MUCUS--The viscid (sticky) secretion of the mucous glands.

OVERT--Open, manifest. Overt attack implies the adaptation and use of principles and methods of attack; and use of weapons and munitions previously developed, known, and commonly accepted in warfare.

PANDEMIC--A widespread epidemic, affecting or attacking all, or a large proportion of, the population.

PARASITE--Plants or animals (including micro-organisms) living on or within another living organism or host, at whose expense they are maintained.

PARTICULATE FILTER--See COLLECTIVE PROTECTORS.

PATHOGENIC--Disease producing.

PENICILLIN--An antibiotic compound obtained from cultures of certain molds which prevents the growth of numerous bacteria and other micro-organisms.

PERSISTENCY--The degree to which a biological or chemical agent remains effective over a period of time in a given area.

PHYSICAL SECURITY--Security against sabotage, espionage, and other hostile activities, destructive acts and omissions by preventing access to key facilities and areas.

PNEUMONIA--Inflammation of the lungs.

POLYVALENT VACCINE--A stock vaccine made up of many strains of the same organism or different organisms.

PPM--Parts per million.

PROPHYLAXIS--Preventive treatment.

PROTECTIVE CLOTHING--Specialized clothing to prevent contact of biological and chemical agents with the skin. There are two types; impermeable, which is airtight; and permeable, which is treated with a material which destroys or neutralizes the agent and allows the passage of air.

PROTECTIVE MASK--A mask completely covering the face for protecting the respiratory system and eyes from biological or chemical agents.

It includes a particulate filter for removing particles and impregnated charcoal for removing gaseous chemical agents from the inhaled air.

PUSTULE--A small circumscribed elevation on the skin, containing pus.

QUARANTINE--Isolation of infected individuals and of possible carriers and contacts for a period of time to prevent disease transmission.

RESISTANCE--The ability of the individual to ward off infection.

RESPIRATORY--Pertaining to the act or function of breathing.

RICKETTSIAE--A class of micro-organisms intermediate in size between the viruses and the bacteria.

SABOTAGE--Any action taken deliberately by an agent or sympathizer of one country to obstruct, or interrupt the war effort within an area controlled by another country; the damage resulting from such action.

SANITATION--The establishment of environmental conditions favorable to health.

SHELTER--A specially constructed or designated refuge for protecting people, records, supplies, or equipment from the effects of a nuclear attack. It may also include protection against biological and chemical agents.

SLURRY--A thin mixture of water and solid material, of the consistency of whitewash, composed of water, calcium hypochlorite,and solid material such as hydrated lime, diatomaceous earth, etc.

SPORES--Primitive reproductive bodies or resistant resting cells, produced by some plants and some micro-organisms.

SPORULATION--Formation of spores.

SPRAY--Droplets of liquid large enough that they tend to fall to earth, wetting surfaces; as distinguished from AEROSOLS. In a spraying operation droplets will usually be produced in both size ranges.

STABILITY--Resistance of a micro-organism or toxin to destruction by chemical materials or physical factors.

STERILIZATION--The process of killing all living cells, especially micro-organisms, by heat, chemicals, or other means.

SUSCEPTIBILITY--State of being readily affected.

TEMPERATURE INVERSION--Increase of temperature of the air with increase of height instead of the usual decrease. This causes a stagnant layer of cool air to be trapped below a layer of warm air, and eliminates the normal vertical currents which tend to dissipate clouds of biological or chemical agents.

THERAPY--The treatment of disease.

TOXICITY--The quality of being poisonous. Especially the degree of virulence of a toxic microbe or poison.

TOXIN--A poisonous substance produced by animal or plant cells.

VECTOR--A carrier, especially the animal or host that carries a pathogen from one host to another, as the malaria-carrying mosquito.

VEGETATIVE CELLS--Non-sporeforming bacteria or sporeforming bacteria in their non-spore state.

VIABLE--Capable of living and developing.

VIRULENCE--Disease producing ability; the relative infectiousness of an organism.

VIRUS--An ultramicroscopic organism, capable of passing through filters, requiring living cells for multiplication.

VOLATILITY--The tendency of a liquid to vaporize.

VACCINATION--Protective inoculation with micro-organisms, killed or attenuated, e.g., against smallpox by inoculation with vaccinia virus; also any act of protective inoculation with a virus or bacteria.

VAPOR--A substance in the gaseous state.

WAR GAS--Common term for a toxic or irritant chemical agent, irrespective of its physical state, which meets certain requirements and has desirable features for use in war.

APPENDIX I

SUGGESTED REFERENCES

The following documents are suggested for further reading, for specific reference and for general background. The titles generally reflect the scope covered by each. The notations GPO, or OTS, indicate that the publications can be purchased from the Government Printing Office, or the Office of Technical Services, Department of Commerce, respectively.

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APPENDIX J

INCLOSURE I:

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